Cave Mania 2005 Proceedings

Downunder at Dover

25th Biennial Conference of The Australian Speleological Federation

2nd–9th January 2005

Edited by Albert Goede and Stephen Bunton

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Cave Mania 2005 Proceedings

Contents

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Front Cover:
Tyrolean traverse in Vallina Cave, Spain
Photo by Ignacio "Nacho" Rafael.

Back Cover:
Jenny Whitby on a lava tongue in the Olaa section of
Kazumura Cave, Hawaii.
Photo by Gary Whitby

PHOTO: JULIA JAMES

FROM THE CONFERENCE CONVENOR

Stephen Bunton

It is vital that the cavers of Australia belong to a viable national body and for almost fifty years the ASF has been that body. To maintain such an organisation requires an enormous amount of work by quite a number of very dedicated individuals. In the past I have felt unable to commit myself to such tasks. Besides the everyday endeavours necessary to maintain ASF, the two major entities which provide the lifeblood for our organisation are the newsletter, *Caves Australia* and the biennial conferences. When it became Tasmania's turn to host the 25th Biennial Conference of ASF, I realised that here was something that could be done to serve the cavers of Australia.

There is no doubt that organising such an event as this requires a great amount of work and I am indebted to the following people for their assistance. Primarily Arthur Clarke was the other driving force. Having been to previous conferences more often and more recently than myself, he was able to advise me on the culture of these events, the necessary protocols, expectations and meeting schedules. He also organised the Photo Competition rules and entries as well as liaising with Rodney Dillon and the overseas visitors including chasing up their abstracts and papers. During the conference he played host to numerous people who stayed at his place in Francistown. Robyn Claire, his partner, offered sage advice on many occasions and ensured that the Artshow and Tasmanian Museum and Art Gallery Exhibitions became a reality. June MacLucas was the organiser of the Artshow and was assisted tirelessly by her husband George. Steve Phipps was and still is, a most meticulous and diligent treasurer. Dean Morgan ably maintained the website. Albert Goede helped organise the abstracts, programme of papers and assisted in editing these proceedings. Greg Middleton helped with the proofreading.

It was decided to hold the conference in Dover because, besides offering the special old-world charm of regional Australia it was closer to the Hastings and Ida Bay caves and this made the running of fieldtrips easier. Tasmania's tourism industry is endowed with a number of high-profile conference venues but holding our event in Dover was much cheaper and in many ways more suitable. CaveMania would not have been such a success without the use of Dover District High School and I would like to thank the Principal, Peter d'Plesse, for allowing us to use the school and for the generosity and support of his staff; cleaner Alanna Hudson and IT teacher Trevor Henwood. Mike Foley and Denise Young of Far South Wilderness Backpackers Inc. accommodated and fed the majority of CaveMania participants. Mick Williams ably transported most of us around the various venues. Esperance Multi-Purpose Centre lent us their data projector and screen.

CaveMania provided an ideal opportunity to showcase various Australian and Tasmanian products and services and so I would like to thank sincerely our sponsors for their support and generosity. In particular I mention Aardvark Adventures for the abseil of the Gordon Dam which was a highlight for many cavers, Anvers Confectionary who provided their superb truffles, Cadbury-Schweppes for the chocolate so well known to cavers, Cascade Brewery for that other essential conference ingredient: beer, Events Tasmania for financial support, The Hastings Experience for the Newdegate Cave tours, adventure cave tours and the BBQ facilities at Hastings Thermal Pool, Lark Distillery for thank yous for the presenters, Mountain Designs for prizes for the Photo Competition, Nick McKim, Greens MHA for Franklin for his donation, Qantas for discounted airfares, Snowgum for prizes for the Speleosports and stationary and Walch Optics for the prize for the Photographer of the Year.

PHOTO: JOE SYDNEY

The Convenor, Stephen Bunton, welcomes His Excellency The Governor of Tasmania, William Cox, at Dover District High School.

Since moving to Tasmania in 1986, I have become very proud of my adopted home and the lifestyle I enjoy. Therefore I was very happy to show off these aspects of my life to all Australian cavers. It is no surprise that the thing I missed most, when I moved to Hobart, was the long-standing friendships I had made in Sydney. CaveMania was a great opportunity for me to catch up with old friends and rekindle relationships. CaveMania also introduced me to many new friends and put names to the faces that I read about in Australian cave literature.

I would also like to say thanks to the many people who stepped up on the spur or the moment to help in the day to day running of the conference, the self-starters, those with initiative that see the work to be done and then pitch in to do it. Most notable in my mind are the Western Australians, Greg Thomas, Ian Colette, John Cugley and Darren Brooks for setting up and running the Speleosports and prusiking competition, Jay and Ross Anderson, particularly Ross for his IT support, Cathie Plowman and Dave Butler for the raffles (one for the victims of the tsunami disaster appeal) and numerous other odd jobs, Steve Blanden who was always there to help and in particular his assistance with the Photo Competition entries, Joe Sydney for amongst many other things, capturing most of the conference in photographs. Julia James from whom I learned so many of my organisational skills quite some time ago, was always there to offer good advice to pitch in with the less glamourous tasks like washing up, Matt Cracknell was a great go-between for CaveMania and the Hastings Experience where he works. These are just the people I noticed in a big way. No doubt I have forgotten many helpers and for that I apologise and thank you despite your having to remain anonymous. Thanks also to my darling wife, Kathy and delightful daughter, Grace who helped immensely. I was not sure what sort of Christmas holiday I could promise them but in the end they thoroughly enjoyed themselves. Likewise I was not certain what I could promise my friends the Evans family Brian, Ruth, Dane and Rhys. They trusted me when I said it would be a good time. As is turned out, it was great and so were they!

I would like to thank those members of Southern Tasmanian Caverneers who could not be persuaded to attend the conference but were willing to run fieldtrips, most notably Ric Tunney, Janine McKinnon and Phil Rowsell. They believe that caving is to be done and not just talked about. I think that deep down we all think that and without the fieldtrips, visiting Tasmania would have been much less enjoyable for all CaveMania participants. The other Tasmanian clubs: Northern Caverneering Club, Mole Creek Caving Club and Savage River Caving Club also ran a plethora of fieldtrips which enhanced everyone's experience of The Caving State. Thanks to the enlightened members of the Tasmanian Department of Tourism, Parks, Heritage and the Arts who relaxed permit restrictions so that a few more people could enjoy Tasmania's iconic caves. Specifically thanks must go to all those cavers who helped with the cleaning of Kubla Khan and thus making the world a slightly better place. Dave Wools-Cobb is to be particularly thanked in this regard.

When I next attend an ASF conference I promise that I will attend all the sessions, listen to all the presenters, enter the photographic competition, participate in the Speleosports, attend the fieldtrips, drink less responsibly at the BBQs, relax, let what is left of my hair down and generally do all those things that I was too busy to enjoy doing at CaveMania.

I would also like to thank all the people who presented papers, posters, workshops or seminars without whom there would be almost no point in coming. Here is your published work, I hope we have done it justice.

Thank you all.

RODNEY DILLON'S WELCOME TO COUNTRY

Stephen Bunton

Over recent years the Southern Tasmanian Caverneers has worked closely and harmoniously with the Tasmanian Aboriginal community.

Much evidence of Aboriginal occupation has come to light in some very significant cave sites. Cavers and Forestry Tasmania have worked co-operatively to ensure that these places are well managed into the future.

As a sign of co-operation and respect the organisers of CaveMania felt it entirely appropriate to ask a member of the local Aboriginal community to welcome us to this place.

Rodney Dillon expressed his concerns about the treatment of Aboriginals in the past and Stephen Bunton reaffirmed the willingness of Australian cavers to work with indigenous Australians to preserve their culture.

Stephen replied that cavers were likely to be much more aware of the Aboriginal occupation of this continent than the community at large, since they are constantly reminded of the Aboriginal presence, through the physical evidence they encounter in caves.

POSTSCRIPT

Rodney Dillon was declared Aboriginal Person of the Year during NAIDOC Week 2005.

PHOTO: JODIE RUTLEDGE

Rodney Dillon during his welcome.

OPENING ADDRESS

TO THE 25TH BIENNIAL CONFERENCE OF THE AUSTRALIAN SPELEOLOGICAL FEDERATION

By The Honourable William Cox AC RFD ED
Governor of Tasmania
Monday 3rd January 2005

I would like to add my welcome to you all at this very important conference. I extend a special welcome to the many visitors from other parts of Australia, and those from overseas who have travelled from as far afield as the United States of America and Iran.

The organisers have certainly chosen a beautiful part of the state in which to hold your conference, home to some of Australia's most extensive and most interesting cave systems.

Although I know it will be hard to distract you from these, I do hope that you manage to find time during your stay to explore more of the state and perhaps indulge yourselves in some of the less arduous pursuits it has to offer such as the exploration of our magnificent wines and fresh foods and dry warm places such as our spectacular east coast.

Although not a caverneer by preference myself, I can make a vicarious claim to a first in the field. The first published record of a caving trip in Tasmania is of a visit in 1829 by Lieutenant-Governor George Arthur and party to an unidentified cave near what is now known as Mole Creek, where, relying only on the reflection of light from the entrance, they entered what the *Hobart Town Courier* reported to be –

"a cavern extending a considerable distance where they groped their slippery and obscure way onwards and downwards where at length they reached a torrent of water bursting through the cavities of this singular grotto, coming we know not whence and going we know not whither!"

Another vice-regal connection involves novelist Anthony Trollope and Sir Charles du Cane, Governor of Tasmania from 1869 to 1874. Anthony Trollope visited Tasmania in 1872 and was smitten. He spoke of *"this beautiful island, the sweetest in climate, the loveliest in scenery, the richest in rivers and harbours."* He concluded that *"were it my lot to take up residence in Australia – I would pitch my staff in Tasmania."*

Caverneering however was one aspect of the Tasmanian experience which he did not extol, as his recollections of a trip made in the company of Sir Charles Du Cane to the Chudleigh Caves in the north of the State record:

"We were cold to the marrow of our bones, wet through, covered with mud and assured that, if we did go on, the journey must be made partly on hands and knees and partly after the fashion of serpents. At last we rebelled and insisted on being allowed to return."

As Trollope discovered, caverneering is by no means a glamorous pursuit and I think that this could in fact be its saving grace.

There is simply no way in which overalls, helmet, boots and mud can be promoted so as to attract the new breed of glamour-seeking ephemeral sportsperson, and hence both the caving fraternity and the caves themselves are spared all but the most dedicated; those who are up to the challenge and the not inconsiderable dangers posed by the sport.

With over 2,750 documented caves containing around 950 species of fauna, Tasmania really must be the speleologist's paradise – partly for what is known about our cave systems and even more significantly for what is not known – with vast areas awaiting thorough exploration, including the Junee – Florentine, were I am told 30 new caves have been discovered in the last month alone.

PHOTO: ROSS ANDERSON

The Governor of Tasmania, The Honourable William Cox, addressing the conference. Seated left to right are Alan Warild, Stephen Bunton, Mrs Cox and Rodney Dillon.

It is no surprise then that Tasmania can boast the first caving club in Australia, the Tasmanian Caverneering Club established in 1946, brainchild of the late Professor Sam Carey who also coined the word *caverneering*. And there is a vice-regal connection here as well with Governor Sir Hugh Binney being the Club's first Patron. Binneys Chambers in the Newdegate Cave were named in recognition of his visit there

PHOTO: JODIE RUTLEDGE

His Excellency, The Governor of Tasmania William Cox (L) is unofficially thanked by ASF President John Dunkley after his address.

PHOTO: JULIA JAMES

Albert Goede talks with Jill Rowling (left) and Mara Silins at morning tea

in 1950. When I say visit I understand that in fact to reach those chambers Sir Hugh was hauled by the legs through the 35 metre entrance tunnel now known as Binney Tunnel.

We have come a long way since Trollope's time when the visitors to the Chudleigh caves were encouraged to leave their moniker on the walls and formations, however your organisation faces an onerous task in protecting karst systems and their all important catchment areas from damage by development of all sorts including dams, quarrying and land clearing. It is always doubly difficult to convince the public of the need to preserve elements of our environment which they cannot see – a problem you share with those seeking to protect our marine environment.

Cave photography, which I notice is an issue to be discussed extensively during the conference, can play an important role here. Our caves are precious for just so many reasons – not the least of which is the treasure trove of information they can supply about the past – plant and animal life, and climatic and geological events.

In Tasmania for instance fragments of thousands of animal bones and stone tools uncovered in the Kutikina Cave on the Franklin River may well hold the key to the lives of the Aboriginal people who inhabited the area over 20,000 years ago.

The Australian Speleological Federation has given practical expression to its stated aim to conserve karst systems. It has been at the world forefront in the development of policies to protect caves from over-visitation through its Code of Ethics, Code of Minimal Impact Caving and Safety Code which have all been modelled elsewhere.

Further, you have long lobbied for the importance of karst systems to be given proper recognition in environmental management plans. I congratulate you for your diligence and many successes in this area.

The scientific study of caves encompasses an extraordinarily wide range of the sciences. The organisers of this conference have managed to attract an impressive array of speakers who will cover many of the various aspects of your field including the biology, conservation, geology and exploration of karst systems, as well as caving techniques, cave photography and mapping and cave tourism.

Your speakers will cover karst systems across Australia and from as far afield as Madagascar, northern Iran and Hawaii. And of course you are ideally situated for some very interesting post conference field trips, with some of Australia's deepest and longest caves at your doorstep.

I congratulate the many sponsors for their valuable support. I congratulate the organisers, in particular your hosts the members of the Southern Tasmanian Caverneers, on putting together a fine programme which has such immediate practical importance as well as long term significance. I do hope you all find the next four days stimulating and satisfying.

It now gives me great pleasure to declare the 25th Biennial Conference of the Australian Speleological Federation open. ■

KEYNOTE ADDRESS

SPELEO MERCENARIES
– CAVING IN THE AGE OF GLOBALISATION

Alan Warild
41 Northwood St, Newtown NSW 2042

When I explained to a non-caving friend the idea of caving mercenaries, of caving in the biggest and best caves I could get to with whoever it took to get there, he replied "Sounds more like caving whores to me".

Way back in the 'old days' cavers used to run 'expeditions' to exotic locations like Tasmania and New Zealand. Now we go there for weekends and tourist trips. Australia's international caving expedition debut was in fact quite early on in our caving history.

In 1965 a bunch of 6 crazies decided to organise an expedition to the Star Mountains in Papua New Guinea - 40 years on it is still one of the more remote parts of PNG - and the world.

It was, however in the late 70s and 80s when it really started happening with expeditions to the Muller Ranges in PNG where we explored some big river caves, ate witchety grubs, and generally played in the mud and slime.

We found a lot of caves in PNG, but even though it is close, PNG is one of the more expensive places to look for caves - difficult access, septic jungles and so far no deep caves to show for it.

Nothing for it but to search for a friendlier caver's paradise. Mexico seemed like a good choice: cheap flights, easy access, big limestone mountains and no stone-age inhabitants. In 1985 we found an 'untouched by cavers' area called Zongolíca and over the next ten years six expeditions found and explored a lot of caves in the 600 m to 950 m depth range, and, eventually we dived a sump in Soncongá to get an Australian first: to break the 1000 m depth barrier, even if 1014 m made it the second shallowest 1000 m+ cave on the list. Zongolíca caves are uncompromisingly vertical and we learnt much and had a lot of fun.

Eventually however, the prospects of going deeper were beginning to look too doubtful to justify the time and effort and it is a long way from home just to go poking around in grotholes…

Fortunately, just as I was wondering where to go next, I got a letter from Jean-Paul Sounier: "You are coming to New Britain, aren't you?". Just as I was thinking about it, Rabaul disappeared under a blanket of ash from a volcanic eruption. Well, that was that - I HAD to go!

The aim was not overly modest: redescend Muruk Cave - nobody had been there for ten years - and dive the sump at -640 m, then explore it to the resurgence to get the Southern Hemisphere's first 1000 m+ cave.

It is always interesting to go on an international expedition as the non-national and French cavers are a great bunch to go with.

It took two expeditions to get all the way through and the Muruk-Berenice traverse still rates as the best sporting cave I have ever done. I have not even heard of any that come close: Spotlessly clean beautiful pitches and wonderfully reflective creamy white rock.

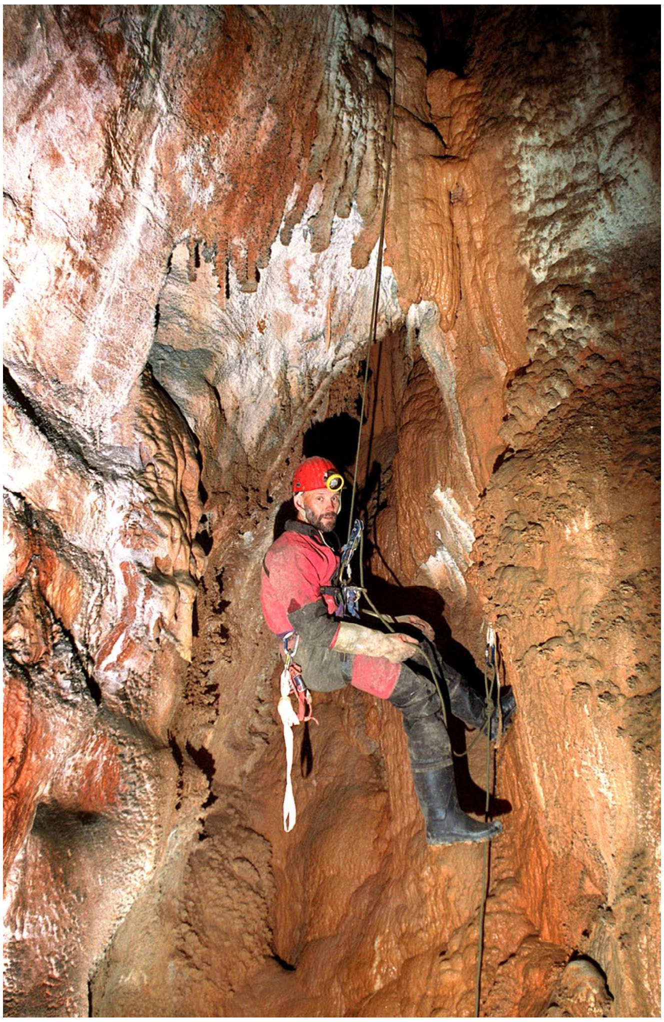


PHOTO: ALAN PRYKE

Alan Warild abseiling in Mutmut Cave, Yarrangobilly, NSW.

You enter Muruk at an intermittent streamsink and it just gets bigger and better as you go: pitches, traverses, swims, rapids, lakes and to finish, a few cumecs of bluer than blue water to climb over and wade through before emerging at dawn to climb back the 1150 or so metres to camp.

The Muruk trips also had the side effect of introducing me to some like-minded caving mercenaries with global caving ambitions.

Ultima 2000 was a French big-budget extravaganza to explore the karst of Isla Madre de Dios in Chilean Patagonia. We had sponsorship from National Geographic, Rolex, Saramite (a French motorway construction company showing


PHOTO: ALAN WARILD

Muruk Cave, PNG.

people how warm and green they really were), and plenty of others.

We managed to spend it all on a leaky boat doing a one way trip south, but we did manage to get a few weeks on and around Madre de Dios.

It must be one of the wildest places on earth. It rained almost every day - usually horizontally. We went caving anyway and just put up with getting wet and cold.

The caves were as expected: young, active, wet and prone to flooding. The glaciated karst is spectacular. We did discover a nice vertical cave that went to an active sump at -375 m and another system just over two kilometres long.

So with all these contacts, where to next? I tagged along on a club trip with the Furets Juenes du Seyssins (Seyssins Young Ferrets) for some prospecting in classic alpine karst in Slovenia and a couple of summer seasons pushing almost 1000 m deep holes in Spain's Picos de Europa. Really though, these were just 'holidays'.

The real objective of any good speleo-mercenary is something really big: Voronia in Abkhazia has been the deepest in the world since the beginning of 2001 at 1710 m. It lost its No 1 spot for a while to Mirolda in France, that was until someone realised that if the depth claimed was correct, the water in the bottom of Mirolda would have to be ~150 m below its resurgence – not likely!

After an official Féderation Français de Spéléologie enquiry, the depth of Mirolda shrunk back to something more realistic.

In August 2003 I got a spot on a Russian/Ukranian/Spanish/French/Australian trip to Voronia. The objective was to push a sump at -1440 m. We got two divers through and they ran out of time and gear at -1680 m looking down another pitch. A follow-up trip would surely follow.

In the meantime, there is an interesting wannabe deepest cave mountain in Southern Mexico - with 2400 m of dye-traced depth potential, there is a world-beater there, it is just a matter of finding it (so I'm told).

This time our group of Australians, Poles and Spanish were with the USDCT (US Deep Caving Team), not that we saw much of them during the weeks we spent bashing around the jungle trying to find the entrance to that world-beater. Towards the end (Why is it always towards the end?) we started down 'Barbie' Cave.

Eventually we reached ~400 m, with the cave still going. This actually got the USDCT out from their underground camp at -180 m to have a look. Another trip would surely follow.

Another northern summer and Voronia was on again, but this time the scene had changed. The Russians and Ukranians had fallen out. The Ukranians wanted 'their' cave back.

The two cavers who made the breakthrough the year before (a Russian and a Ukranian) wanted to go back with their friends rather than a national expedition with someone else calling the shots, so off we went in July - just before the first of two Ukranian expeditions... We had just three weeks to get down there, push it to the limit, and get out. Everything was organised to perfection - sacks were pre-packed and marked with their destination, there was no spare time and minimal allowance for time out.

We got two pushes, on the first, Ilia and Mouhen discovered a couple of new pitches and probably passed the old record.

On the second, Denis and I spent two very cold nights beyond the sump, camped at the foot of a waterfall pitch, and bottomed two more pitches to a sump that we surveyed to a depth of 1830 m below the entrance. Despite the haste and cold, it was a euphoric finish, but it did not last.

In August 2004, the big Ukranian expedition descended

Alan Warild (R) with (L to R) Denis Provalov, Maxim Dzaganiya, Andrey Shumeyko at the -1400 m camp on the way up from the July 2004 bottom of Voronia Cave.

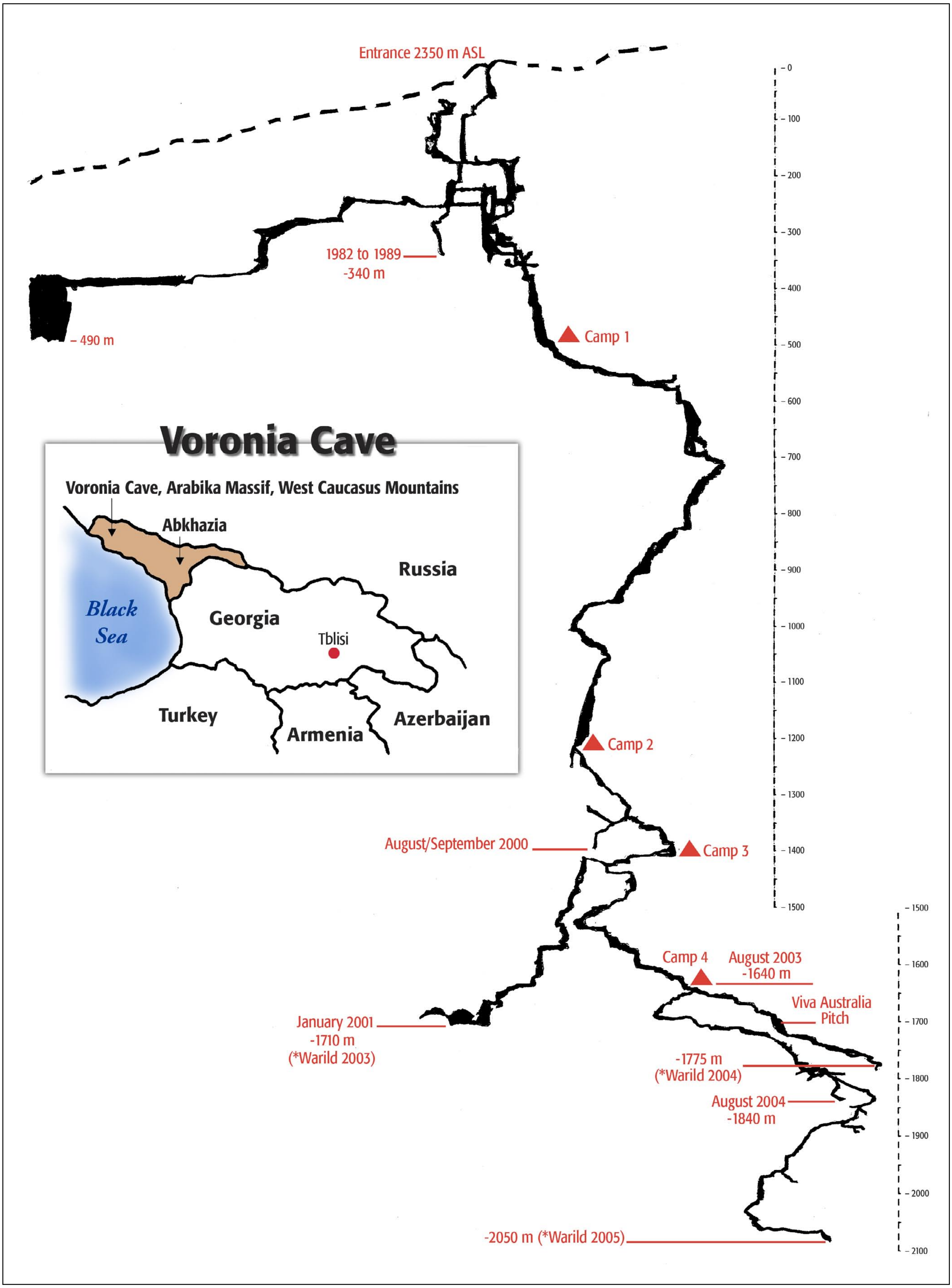


Figure 1: The Voronia Cave System, detailing exploration by Alan Warild. Adapted from Klimchouk, A (May 2005) The Call of the Abyss Project.

Karst on glaciated pavements in Patagonia

and dived 'our' sump, but the cave only continued for another 10 m. Then, towards the end (Why is it always towards the end?), one of the party wiggled down a tiny passage that they had been camping beside and walking past for over a week.

They surveyed this new passage to a depth of 1820 m and claimed a record (simultaneously claiming that our depth was wrong). The October Ukranian expedition was definitive. The party followed one of the many remaining leads and was stopped at a depth of 2080 m. Quite fittingly, the expedition was led by Yuri Kasjan, who back in the late 90s was not allowed to play with the 'big boys', so he went poking around in some of the other caves that did not go anywhere, including one they called 'Voronia' because it had crows living in the entrance, and found a meandering passage going off half way down a pitch.

POSTSCRIPT

• While I was presenting this talk, the Russian group was preparing to return to the area. As they were approaching base camp, their helicopter crashed. No one was killed, but several injured cavers had to wait two days while another helicopter was found to get them out.

• Alan Warild bottomed Voronia Cave again in July 2005 as a member of a survey party which confirmed the cave's depth at 2050 m. ■

Living in the helicopter wreckage

PRESENTATION

CAVE BIOLOGY FOR BIOLOGY TEACHERS

Stephen Bunton
The Friends' School, PO Box 42 North Hobart 7002

PHOTO: ARTHUR CLARKE

Tasmanian Cave Spider, Hickmania troglodytes.

ABSTRACT

A closer look at cave biology can illustrate a number of important biological principles studied by pre-tertiary students. This presentation was first given to the 2003 BIOTA Conference for the Tasmanian Biological Teachers Association. It introduces teachers to some of the specific terms and some of the interesting cave invertebrates found in Tasmanian caves. The main concept explored is that of geographical isolation, its affect on evolution and the resultant adaptations of cave invertebrates. This presentation is included on the CD of these proceedings and was originally illustrated with some cave fauna photographs by Stefan Eberhard.

AN OVERVIEW OF CAVE AREAS AND THE INVERTEBRATE CAVE FAUNA IN TASMANIA

Arthur Clarke
School of Zoology, University of Tasmania, Private Bag 05, Hobart, Tasmania 7001

ABSTRACT

There are 141 recorded cave areas included in the ASF Karst Index for Tasmania. Forty-one (41) of these are non-karst cave areas: principally in quartzite, sandstone, mudstone, metamorphic rocks, granite, dolerite or basalt; the remaining one hundred (100) are karst cave areas in limestone, dolomite or magnesite. Although there are estimates suggesting that there are 4,000 caves in Tasmania, presently (at November 2004), there are 2,800 documented caves: 150 non-karst caves and 2,650 karst caves. In addition there are another 161 documented karst features including poljes, blind valleys, swallets, springs and

The major karst areas are: Junee-Florentine: 655 caves; Mole Creek: 509 caves; Ida Bay: 274 caves; Mount Cripps: 231 caves; and Gunns Plains: 151 caves. Invertebrates have been recorded from about 20% of the known karst and non-karst caves in Tasmania. Approximately 1040 species of invertebrate fauna have been recorded from these caves, based on records collated in a database commenced in 1997 (Clarke, 1997a) and subsequently updated and listed in a student (MSc) database (Clarke, 2005). It includes around 6,800 occurrence records based on collections and observations from 551 caves and another 14 efflux spring or mound spring sites in Tasmania. Just over 21% of the known invertebrates are aquatic species. The greatest species diversity amongst the aquatic invertebrates is found in hydrobiid snails, crangonyctoid amphipods, syncarid shrimps, phreatoicids and aquatic isopods.

As might be expected in cool temperate cave areas, the major terrestrial species are the spiders, harvestmen, mites, pseudoscorpions, beetles, cave crickets, springtails, isopods, millipedes, oligochaete worms and land snails. Many species remain undetermined or undescribed. The karst bio-space (Clarke, 1997b) in Tasmania is complex with a variable development of aquatic and terrestrial habitats. Analysis of the karst bio-space in Tasmania (in November 2004) reveals several areas of high species diversity reflecting in part the intensity of study of those karsts: Ida Bay: 291 spp., Mole Creek: 195 spp., Hastings: 191 spp., Bubs Hill: 190 species, Junee-Florentine: 175 spp., Gunns Plains: 134 spp., Franklin River: 127 spp., Loongana: 114 spp., and Precipitous Bluff: 109 spp.

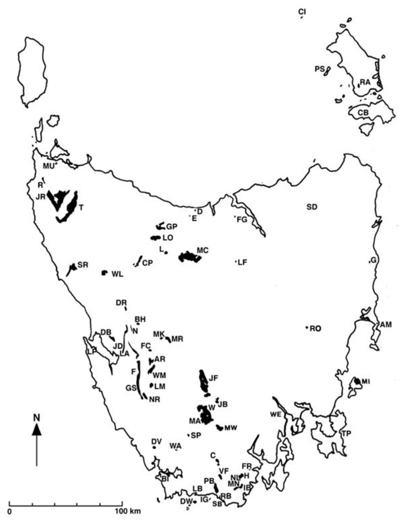
The number of species recorded from different karst areas does not only reflect the varying development of karst bio-space, but to some extent is also dependent on the degree or intensity of study. At present, the greatest numbers of troglobitic (cave obligate) species are recorded from the Ida Bay, Mole Creek, Loongana, Precipitous Bluff, Junee-Florentine and Flowery Gully karst areas (Clarke, 1997a). ■

PHOTO: ARTHUR CLARKE

Fungivorid mycetophiloid gnat on agaric fungus in cave at North Lune, Tasmania. Photo Competition First Prize for a Print in the Scientific category.

PHOTO: ARTHUR CLARKE

Cave adapted Anaspides *(Tasmanian Mountain Shrimp)*
Photo Competition Second Prize for a Print in the Scientific category.



Map with locations of the principal cave areas in Tasmania with known records of invertebrate species; cave areas are shown with their respective (one or two letter) ASF area codes. Caves are located in carbonate rock karst areas and non-karst areas, e.g., in dolerite, granite, mudstone or schist (see Clarke 1997a; 1997b). [Adapted from Matthews (1985: p. 7.0).]

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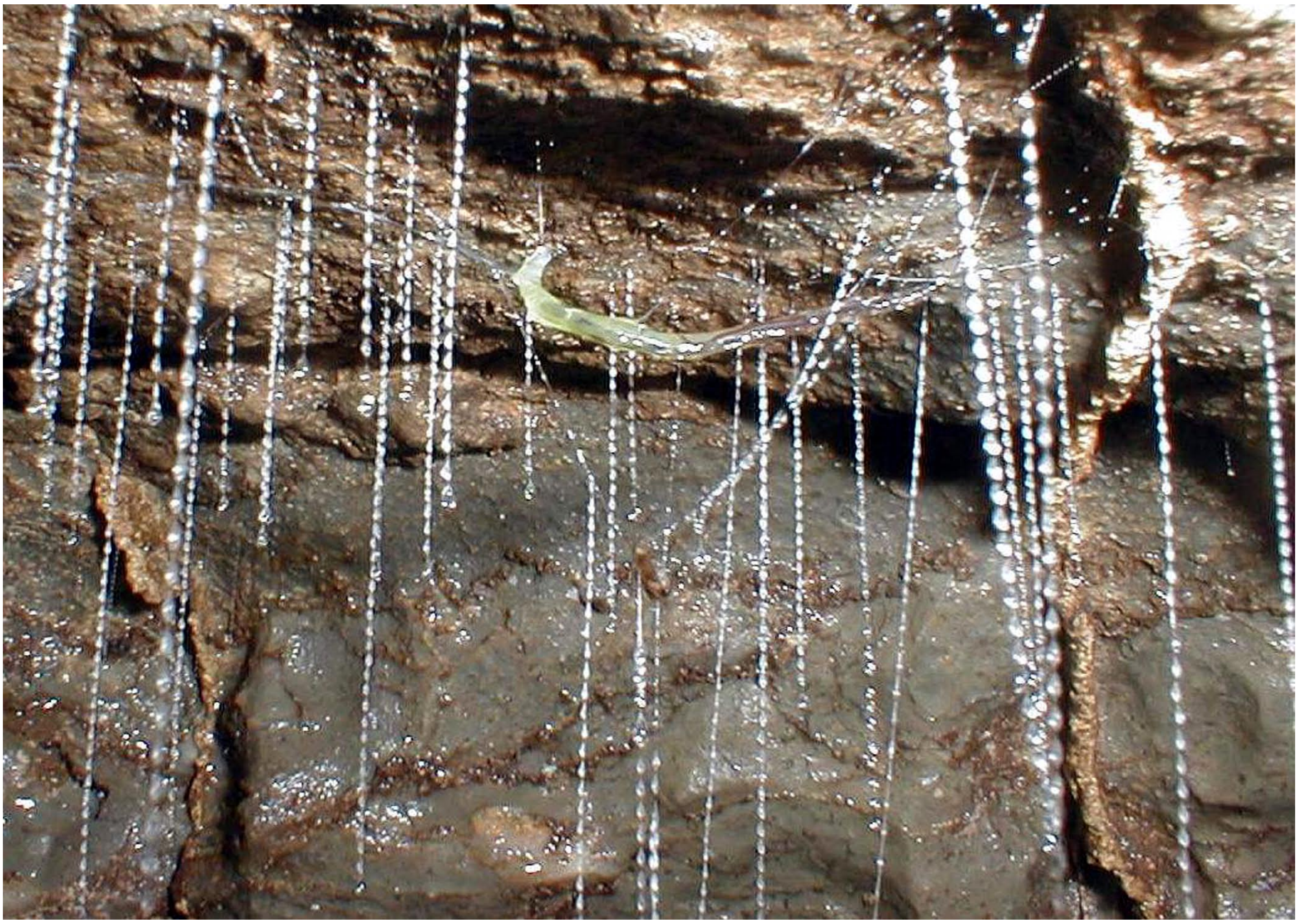
BIOLUMINESCENT GLOW-WORMS:
IS THERE A DIFFERENCE BETWEEN CAVE AND RAINFOREST POPULATIONS?

David Merritt, Niu Changying, Claire Baker and Glenn Graham
School of Integrative Biology, The University of Queensland



Arachnocampa tasmaniensis.

INTRODUCTION

Glow-worms are the larvae of a fly from the family Keroplatidae. The unique feature of glow-worms is their ability to bioluminesce—to produce light. Because they are not very mobile the larvae must trap flying insects in their webs, and they use light to bait the trap. The larvae build a structure composed of a horizontal mucous tube suspended by a network of threads from the earth or rock substrate. The larva moves back and forwards in the tube and can turn in its own length. The larvae spend a considerable amount of time maintaining their "snares"—the many fine silken fishing lines that hang downwards, decorated by periodically placed sticky droplets. We have made artificial glow-worm habitats to keep larvae in the laboratory and used invisible infrared illumination to video record them as they maintain their snares through the night. Larvae bioluminesce and behave as normal while they are being observed. The production of fishing lines is a very stereotyped behaviour, originally described by Stringer (1967) for *Arachnocampa luminosa*, the New Zealand glow-worm. Larvae glow very brightly when an insect is caught in their web, although we are not sure exactly why.

LIFE CYCLE

The larval stage lasts many months, finally forming a pupa that lasts about a week. The pupa is suspended from the hardened thread-like remnants of the mucous tube that held the larva. One of the most obvious differences between *A. luminosa* and the Australian species is that *A. luminosa* pupae hang vertically from a single thread while all Australian species hang horizontally from a front and rear thread.

The adults look like large mosquitoes with very long legs. They are sluggish fliers and frequently rest on the walls of embankments or caves. They are very short-lived, surviving for only a few days after emergence from the pupa and apparently do not feed. The males will find a female pupa and wait for her to emerge so that they can mate. Males are more slender than the females that emerge from the pupa with an abdomen swollen with eggs. The female flies live only two days so mating and oviposition (egg laying) begin immediately upon emergence. Each female lays 130 eggs that take 7-9 days to hatch (Baker and Merritt, 2003).

BIOLUMINESCENCE

The bioluminescence is produced by internal cells located in a swelling at the posterior end of the larva. The blue-green light is visible through the transparent cuticle. The light producing cells are surrounded by a reflective structure composed of very fine air-filled tubes that appear as a white mass when examined closely. The light-producing chemical reaction is similar to the well-known firefly luciferin/luciferase reaction. However the enzyme and substrate are not identical to those used in fireflies (Viviani et al., 2002).

Bioluminescence output can be rapidly modulated, for example, when disturbed or exposed to bright light, larvae will douse their own light. In some caves of New Zealand the glow-worms can be made to increase the intensity of their light by splashing the water in these otherwise quiet caves. Glow-worms switch off their bioluminescence when exposed to daylight or intense torchlight. In caves they bioluminesce more or less continuously however one of our aims is to test this utilising time-lapse photography in a cave.

We have shown that their light output is temperature dependent. Within an acceptable range, light output increases exponentially with temperature, but at higher temperatures light output ceases and glow-worms show deleterious effects. Our experiments so far have used *A. flava* from south-east Queensland rainforest. It is likely that temperate species such as those from Tasmania will have a much lower range of acceptable temperatures.

GLOW-WORMS IN CAVES

In caves where the airflow is gentle the snares can reach 50 cm in length. In rainforest where they are exposed to stronger air movement they are usually shorter.

The distribution of glow-worms is determined by their sensitivity to desiccation. They quickly die when exposed to low relative humidity or excessive air movement hence they are found only in the most sheltered habitats such as heavily treed, shady, moist gullies or in caves. It is in caves that they reach their highest density, producing spectacular displays of bioluminescence. In most cases the caves that contain glow-worms are within or near rainforest patches or tree fern-lined gullies, suggesting that caves are a secondary, although very suitable, habitat for these insects. Not all caves have glow-worms. Our surveys show that they occupy only those caves with organic input from the outside environment, usually in the form of a stream. Glow-worms are common in wet boulder caves associated with underground streams. In Victoria and Queensland we have collected glow-worms from granite boulder caves in areas where we would not otherwise expect to find them because rainforest is not found nearby. These populations may be relicts of a distant past when the surrounding vegetation was more lush. In caves, glow-worm numbers can fluctuate depending on the season and the history of floods.

More research is needed to find out what characteristics determine their population levels in caves. They are rarely found deep in caves, rather they are usually found near cave entrances, and are true troglophiles.

They show some adaptations typical of cave animals, including reduced pigmentation. Glow-worms from the interior of caves are a creamy colour due to their visible internal organs. By contrast, glow-worms that experience daylight at the mouth of the same cave have brownish pigmentation of the hypodermis especially in the head region. The degree of pigmentation is due to the environment rather than genetically predetermined.

SPECIATION AND GENE FLOW IN GLOW-WORMS

At the start of our work three species of glow-worm had been described in Australia: *Arachnocampa flava* from south-east Queensland, *Arachnocampa richardsae* from the Blue Mountains region, and *Arachnocampa tasmaniensis* from Tasmania. Claire Baker, as part of her PhD project, has identified 5 additional species: *A. tropicus* from north Queensland, *A. girraweenensis* from northern New South Wales, plus *A. gippslandii, A. otwayensis and A. buffaloensis* from Victoria.

Despite the geographical separation of glow-worms within Australia and New Zealand, the different species are remarkably similar in appearance and life habits, however, there are regional differences. With the help of an evolutionary tree (termed a "phylogeny") based on DNA sequence analysis, indications are emerging that the most ancient species, namely the Tasmanian, Mt Buffalo and New Zealand species are more cave adapted than their relatives located in rainforest along the Great Dividing range. These species tend to be larger and have longer snares than their northern neighbours, even when found in rainforest. Our next series of experiments will involve collecting glow-worms from within individual caves of a karst region as well as from nearby rainforest. Using gene sequences called "microsatellites" we hope to discover how much migration has taken place between individual caves and between caves and rainforest populations. This information will be useful in managing threatened, relict populations and those under tourism pressure. ■

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POSTER

ARTHROPOD ECOLOGY IN A BAT MATERNITY CAVE

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PHOTO: GARRY K SMITH

Bentwing bat, Miniopterus schreibersii.
Photo Competition Third Prize for a Digital photograph in Scientific Category.

Bat Cave, Naracoorte, South Australia, is the larger of only two maternal sites for the large bent-wing bat (*Miniopterus schreibersii bassanii*). Guano dropped by these bats in the maternity chamber provides a habitat for an extremely diverse arthropod community.

Despite a comprehensive species inventory from previous invertebrate surveys, the ecology of arthropod species in the cave remains completely unknown.

This study seeks to elucidate and explain temporal and spatial patterns of arthropod diversity and abundance in the maternal chamber.

Pitfall traps, open for 48 hours, bimonthly, have been positioned in 18 guano piles throughout the maternal chamber. The traps have been placed in pairs at the top and bottom of piles to ascertain the importance of fresh guano to the arthropod populations. A range of environmental factors including pH, moisture content and guano deposition rates are being examined to evaluate their micro- and meso-scale affects on arthropod populations.

Preliminary data indicate that guano is usually slightly acidic, with the tops of guano piles strongly basic (pH 8.0-9.0). The abundance of species of Acarina, Coleoptera (Carabidae, Histeridae and Anobiidae), Diptera (Phoridae), and Pseudoscorpionida (*Protochelifer naracoortensis*), has been found to be higher on the tops of piles where guano deposition and moisture content are higher. Arthropod abundance and diversity are postulated to be strongly linked to seasonal guano deposition, peaking over summer months. Further studies, beyond the scope of this project, should include research on fungal and microbial diversity which, apart from guano, form the basis of the maternal chamber food web. Detailed ecological information on species endemic to the maternity chamber would also greatly enhance management and conservation practices for this fragile environment. ■

KARST AND SUBTERRANEAN WETLANDS
– OPPORTUNITIES FOR RECOGNITION OF THESE ENVIRONMENTS IN AUSTRALIA

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PHOTO: ANNE WOOD

Part of the stream and root mats in WI9, WA.

ABSTRACT

The protection and conservation of the environment is an issue that has received a large amount of attention in recent years. As speleologists, we would consider that the karst environment also needs acknowledgement, recognition and protection. Some opportunities for recognition and environmental protection are found within a number of areas. The level of protection afforded by different international treaties and conventions varies. Likewise, the management of sites can allow for recognition under Australian legislation and policy. Each treaty or convention provides a different focus and a range of management tools.

There are a number of relevant international treaties and conventions. Of particular value are the Ramsar and World Heritage Conventions. There are also Australian National Heritage Lists. For example, there are new amendments to the Environment Protection and Biodiversity Conservation Act 1999. These will be briefly discussed, particularly in relation to how karst areas, or subterranean wetlands may fit into these categories.

There is often a lack of information and resources to obtain the data required. In some cases nominations and land management are made with minimal information. There is a need for more open communication between managers/planners and groups that have local knowledge. It is suggested that speleological organisations are in a position to provide useful input. Thus, Government collaboration with speleological groups is an important part of the nomination and management process.

This paper outlines the primary methods that can be utilized to recognize and protect unique environments such as karst systems. It is suggested that speleological groups and individuals with speleological knowledge and expertise consider the karst systems that they are familiar with. It would be excellent if a profile of significant karst systems and unique subterranean wetlands were to be developed. This could provide land managers and Australian Governments with a source of priority sites for listing and protection under international conventions or Australian methods.

INTRODUCTION

In October I attended the first International Workshop on Subterranean Wetlands, held in conjunction with the Limestone Coast 2004 Conference. This was held at Naracoorte in South Australia and there were many interesting papers presented. The delegates also participated in numerous field trips – looking at caves, cenotes, wetlands and other areas of karst in the region. My attendance and associated learning gave me enthusiasm and motivation to share what I discovered with other ASF members. I do not consider that I am a professional in this area, or someone with specialized expertise in this area – just a local speleologist with a passion for karst. Upon my return to Perth, I participated in a information workshop on the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the recent heritage amendments. This paper will briefly outline these and discuss the new changes. I hope that this paper presentation arouses your interest and stimulates you to take further action to benefit our Australian karst. I would like you to consider your karst area and assess how it is protected or how it can be protected through the methods that are outlined.

THE SIGNIFICANCE OF KARST ECOSYSTEMS

We know that caves and karst systems are significant. Research has shown that karst is a complex and dynamic system with connections. I like the three 'inter' words to describe karst: integrated, interactive and interrelationships. I hope that every caver is familiar with Yuan's (1988) paper that outlines the components of the karst environmental system. These being life, energy, water, gases, soils and bedrock. You would know that there are amazing 'connections' in karst systems and that water plays a special role. Williams (2004) outlined a number of lessons from science, principles that can be utilized to guide sustainable management of karst. The two that really made sense to me, particularly in relation to this paper, were about the importance of the epikarst (in controlling autogenic recharge) and how conventional groundwater models do not apply to karst (karst having 'triple porosity'). I have seen that karst is a vulnerable ecosystem – where both the 'water' and the 'rock' are considered a significant resource to humans.

So we know that karst environments, or karst systems, are special ecosystems – ones that also contain aquifers, cave ecosystems, aquatic ecosystems and groundwater dependent ecosystems. You will have seen that karst ecosystems contain both biodiversity and geodiversity. Yet water is a part of this relationship too. Indeed, *"water is the engine that drives karst processes in the karst environment, like blood in the body"* (undetermined source). Research has shown that groundwater divides and catchment boundaries in karst may not coincide with surface divides. So if we think again of connections in karst – where do surface wetlands and subsurface wetlands begin and end?

WETLANDS AND SUBTERRANEAN WETLANDS

I will not define 'What is a wetland?'. This has been documented by several authors (Worboys et al 2003, EDO 2001). I would like you to think of your definition. Then, visualize a wetland you are familiar with. Does it include water? Perhaps it is a lake, a swamp or a creek. Does it have fauna? What do the fauna depend on? Is it a significant wetland? How is it protected? Is it protected?

Now, think about the caves that you have visited. Think of a subterranean wetland. What do you see? How much water is there? Is the water always there? What are the characteristics of this place? Where is the cave life? What would affect the values of that area? Is it important? Is it protected? How can it be protected? Do you know?

Protecting karst is not just about preserving natural features that are beautiful or that have scientific value. The environmental implications in karst areas are comprehensive. In fact, real management of karst is an essential component of water resource management. Another document that I hope that all cavers are familiar with is the *IUCN Guidelines for cave and karst protection* (Watson et al 1997). Guideline 21 states that *"the establishment of protected areas is not, in itself, enough to ensure karst protection"* (1997:16) and that *"more than in any other landscape, a total catchment management regime must be adopted in karst areas"* (1997:20). You may be familiar with the term integrated management or integrated catchment management. As cavers and speleologists, we need to keep in mind that this is what's required for management of karst systems.

The key themes of this paper include: wetlands, karst and a combination of the two. Specifically we are discussing subterranean wetlands. Now that we have conceptualized them, the second part of this paper is about recognizing these environments as being significant and examining ways in which these environments can be protected.

INTERNATIONAL PROTECTION

First, let us look at the wetlands. Do you know how wetlands in your state, or more broadly, in Australia are protected? There is a range of policy and legislation regarding wetland protection (Anderson in press this volume). At an international level there are two related instruments:

(1) The Convention on Wetlands (Ramsar Convention 1971).

(2) The Convention for the Protection of the World's Cultural and Natural Heritage (World Heritage Convention 1972).

I encourage you to have a look at sites recognized by the World Heritage List and also the Ramsar Convention. Consider what karst systems are represented by these International Lists. And consider whether that site was nominated for the karst values or its other environmental values. I was certainly surprised! Particularly examine the Australian sites and note the lack of recognition of our unique karst environments. Hamilton-Smith is currently undertaking a review of these sites and would like further involvement of local speleologists in this process.

THE RAMSAR CONVENTION

The Convention on conservation and sustainability of wetlands was agreed in 1971 at a meeting in the Iranian town of Ramsar, and has since become generally known as the Ramsar Convention. It has worked to further the conservation and effective management of wetlands ever since.

The Ramsar Convention in particular is significant in that it was the first International Convention promoting sustainable development. This is referred to as the 'wise use' of wetlands (Phillips 1998). The broad aim of the Ramsar Convention is to *"halt the worldwide loss of wetlands and to conserve those that remain through wise use and management"*. (Phillips 1998). Are you aware that Australia was one of the first nations to become a 'contracting party' to the Ramsar Convention? Australia was

Tim Moulds searching for fauna in the subterranean wetlands of a significant karst system at Cape Range, WA.

also the first nation to nominate a wetland to the Convention in May 1974 (Giblett and Webb 1996). As a contracting party, Australia has committed to protect wetlands, establish wetlands conservation in land use planning and to regularly report on national activity in relation to wetland conservation and management. Australia's National Wetland Policy was released in draft form at the 1996 Ramsar Convention (and later adopted in 1997). The 1996 Ramsar Convention is particularly significant for another reason.

Are you aware that the sixth International Conference of contracting parties to the Convention on Wetlands was held in Queensland in 1996? It recognized karst and acknowledged the significance of subterranean wetlands. It was decided that a special program should be set up to examine and advise upon the issues relating to karst and other subterranean wetlands. A small working group met in Slovenia in 1998 and prepared a series of recommendations for implementation of the subterranean wetlands program. These were accepted; the formal recognition of subterranean wetlands of international importance has since proceeded. In 1999, these specific guidelines were released.

The parties agreed to include subterranean karst wetlands as a specific wetland type under the Ramsar Wetland Classification System. It was recognized that some cave and karst systems are natural underground wetlands. These areas constitute a resource of ecological, scientific, cultural , aesthetic and recreational values. These karst wetlands also provide an environment that is habitat for specialized vertebrate and invertebrate species.

Cavers are aware (and the research supports this) that the subterranean environments form unique ecosystems. They provide habitat for a range of animals that are highly dependent on a specialized ecosystem and adapted to living underground.

Many of these special subterranean creatures are endemic species that are restricted to a single cave or karst area. As such, these special fauna may also be considered to be rare or endangered species (and can have some form of legislative protection).

There is currently one Australian karst site that is internationally listed as a Ramsar (subterranean) site – the internationally important karst systems of 'the Dales' at Christmas Island. I'm sure that you could think of the caves that you have seen that have subterranean wetlands. The Limestone Coast 2004 Conference (referred to in the introduction) discussed the importance of sites in South Australia such as Ewen Ponds, Piccaninnie Ponds and a number of significant cenotes.

You can find the specific criteria at www.ramsar.org. The Department of Environment and Heritage (DEH) has produced a 'subterranean wetlands' information sheet (DEH 2004). This information sheet outlines other highly significant subterranean wetlands as occurring in:

- Cape Range and Barrow Island – WA
- Calcrete aquifers of inland, central arid zone of WA and NT
- Limestone Coast – SA
- Wellington Caves - NSW
- Wombeyan Karst - NSW
- Ida Bay Karst – Tas
- Mole Creek Karst – Tas
- Junee-Florentine Karst – Tas

I would like to mention some specific sites in WA that need consideration and that I consider would fit the criteria for significant karst 'subterranean' wetlands.

(1) The Nullarbor karst system.

Specific sites include significant karst features on the Roe Plain (recent finds indicate further significant subterranean wetlands) and caves such as 6N46 and 6N2 with its microbial mantles.

(2) Cape Range.

The karst plain to the West of Cape Range has considerable subterranean biodiversity, particularly C215 and the Bundera Cenote. However the Canals and biodiversity of subterranean fauna in C163 are also significant. The blind cave gudgeon (*Milyeringa veritas*) and the blind cave eel (*Ophisternon candidum*) are protected as threatened species. These are Australia's only troglobitic (stygobitic) vertebrates.

(3)The Swan Coastal Plain.

At Yanchep and at Augusta-Margaret River, particularly the Leeuwin Naturaliste Area – between Augusta and Yallingup there are caves with streams such as WI63, WI49 and WI51 that contain significant subterranean wetlands. Other caves such as WI9 and AU14 are also significant. Some of these particular sites are protected as a 'threatened ecological community' under the EPBC Act. They contain aquatic root mat communities (No: 1,2,3,4), invertebrates and the communities are listed as 'critically endangered'.

(4) Kimberley region.

In the West Kimberley there are some caves that contain small streams and pools of water. In KN 109 and KN66 there are pools that are associated with roots, root mats and mud banks, which support a diversity of fauna. Caves such as KN1 have permanent pools of water that contain subterranean fauna. These areas need further research to determine their significance.

(5) Karst region north of Perth.

SH 21 is an example of a significant karst environmental system containing wetlands. Subterranean fauna are still being collected from this cave.

THE WORLD HERITAGE CONVENTION

The UNESCO (United Nations Educational, Scientific, and Cultural Organisation) is about protecting areas of outstanding universal value. The Convention for the Protec-

An example of a surface wetland, the Ramsar wetland of Bool Lagoon in SA.

tion of the World's Cultural and Natural Heritage is defined to be balanced, representative and credible. Thus, Natural Heritage and Cultural Heritage are recognized through this mechanism. For a site to be declared a World Heritage Site, the State Government needs to recommend this to the Australian Government. There are several karst sites in Australia which have been listed. However, they may not necessarily be recognized for their karst values. You may be aware that the WA Government is in the process of preparing a nomination regarding the Cape Range karst area (including the Ningaloo Reef). You can find out more information from www.whc.unesco.org

AUSTRALIAN LEGISLATION

There are a number of policy documents that relate to aspects of karst systems and their protection. Each state may have particularly relevant legislation – for example, protection for listed Threatened Species. However, In particular, there is protection at a National Level that is contained within the EPBC Act. This is the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999.* It is a statutory mechanism that provides protection in matters of National environmental significance. Thus, important subterranean wetlands can be protected through this mechanism.

The main categories are significant and you need to be aware that "Matters of National Environmental Significance" are defined in a certain way. This includes:

(1) Declared World Heritage Properties and values.

There are about 788 World Heritage listed properties (611 cultural, 184 natural and 23 mixed). Australia has 16 sites. Of these there are several that contain karst. Hamilton-Smith (Wong et al. 2001) stated that the Mulu 2001 Asia Pacific Forum on Karst Ecosystems and the World Heritage "*made recommendations about karst systems that are of outstanding universal value.*" Are you familiar with this document?

(2) The ecological character of declared Ramsar wetlands.

As discussed earlier, karst systems may have recognition for their (surface) wetlands systems. With the implementation of the "subterranean wetland" classification, the subsurface karst wetlands can also be declared Ramsar Wetlands. There are about 1400 sites on the Ramsar List of Wetlands of International importance.

(3) Listed Threatened Species and Threatened Ecological Communities.

There are several categories that are considered matters of national environmental significance. The EPBC Act has a register of critical habitat and this includes the Threatened Species and Threatened Ecological Communities.

MATTERS TO CONSIDER:

(1) The EPBC Act is administered by the DEH and it can only protect sites if they are already acknowledged – ie World heritage, National Heritage, Ramsar wetlands, Migratory Species and EPBC Act List (listed threatened species and threatened ecological communities).

(2) If something is on a 'State' list, ie the WA threatened species list, then that is not protected under the EPBC Act. You need to remember that the State List is different to the Commonwealth List.

(3) Find out what karst systems are on Commonwealth land – they are protected under the EPBC Act.

(4) The EPBC Act has 'heritage amendments'. Now there is a Commonwealth Heritage List (CHL) and a National Heritage List (NHL). You may be familiar with the Register of the National Estate (RNE). This is different from the CHL and NHL. The RNE was administered through the Australian Heritage Commission that has become the Australian Heritage Council.

(5) Look at the RNE sites listed, as an individual can nominate to the National Heritage List – the Commonwealth Government only transferred across sites on its own land.

There is an assessment and approvals regime in relation to the EPBC Act. In particular, Part 3 of the Act is in relation to the actions that will affect either Commonwealth land or matters of environmental significance (as defined earlier). It is important that speleological groups are familiar with this legislation and regularly look at the 'invitations for public comment' section on the DEH website (each case is open for ten days comment only).

The protected matters search tool is at deh.gov.au/erin/ert/epbc/index.html. The important point to note is that community groups can suggest conditions for the DEH to include in a 'manner specified' when the Government is making an assessment decision. The 'Register of the National Estate' is managed by the Australian Heritage Council. It used to be the Australian Heritage Commission (1976-2003). There are 13,000 sites of natural, cultural and historic significance.

National Heritage

Are you aware that a new National Heritage System started on the first of January, 2004? The following information is taken from the DEH fact sheets and the workshop by the World Wide Fund for Nature (WWF) (Kennedy 2004, pers. comm). The criteria for NHL are different from those of the RNE. There is no protection for places on the RNE unless the site is on Commonwealth land. Sites on Commonwealth land were automatically transferred to the NHL by the Australian Government. It is important that you are aware that a site needs to be on the NHL to be considered of outstanding heritage value.

Individuals can nominate to the NHL. The site's tenure is not a significant factor. There are criteria for natural, historic or indigenous places that are of 'outstanding heritage value'. They are sites that the community considers as being of outstanding significance.

Commonwealth Heritage

The Commonwealth Heritage List includes sites of *'significant heritage value'* that are leased or owned by the Australian Government. A management plan is required for the sitebefore it can be listed. I am advised that it can be stated that a site meets the criteria, however further funding may be needed to undertake further research to obtain the *evidence.* There is funding for this process under the *Distinctly Australian program* for the purpose of *identifying, managing, promoting and conserving* places of significant heritage value.

If you would like more information there is a website and a number of fact sheets are provided by DEH. www.deh.gov.au

OTHER ASPECTS TO CONSIDER

I have found that in many circumstances, sites are acknowledged and protected for their biodiversity, but their geodiversity may get overlooked. In relation to karst systems of particular significance is that the NHL criteria allow for sites to be protected for geological reasons, as part of *natural history.* Thus geoconservation of karst can be included as a reason that a karst area has outstanding heritage value.

The final day of the Limestone Coast Conference (held at Naracoorte 2004) was a special workshop on Ramsar and Australian Subterranean wetlands. It was decided that principles needed to be developed regarding components of subterranean wetlands. Participants discussed the need for nominations of Australian karst systems to the Ramsar Convention.

The process for nomination is understood to be similar to that of the World Heritage Nomination, in that, the land manager needs to nominate an area. The State Government would also need to agree to the nomination. This would then have to be accepted by the Commonwealth Government who then notify the Ramsar Secretariat. The process itself has conditions, such as the need for consultation with the community and the existence of a management plan.

The aim in presenting this paper is to raise the awareness of ASF members to this new category of the Ramsar Convention and the EPBC Act Amendments. It is hoped that local speleologists and speleological groups could liaise with land managers, ASF and ACKMA to identify Australian sites of significance in karst systems. Generally there is a lack of information regarding karst areas. In many cases, information held by Government or land managers may not be full and complete. Some information about a karst area may be found in the local community (such as speleological groups) or it may not yet be in existence.

It is important that decision makers have access to all information about lands under their power/control/management. It is hoped that this will lead to better land management and protection of caves and karst systems. This is an ideal opportunity for speleologists to raise the awareness of the unique nature of karst systems and the particular significance of a local karst area with the local land manager and the state government. The management authorities (be it private landowner or government department) can utilize speleological knowledge, experience and expertise in best practice land management. It would be excellent to see more open communication and consultation regarding Australia's environment, particularly karst areas.

I would like you to think about what knowledge, and information you (and your speleological group) have about a particular karst area. You could consider appropriate ways of sharing that information with land management agencies to enable future protection of our cave and karst systems. We need to consider what we know, what we think is significant and document the significant karst values and aspects of a particular area. Those present at the Limestone Coast Conference subterranean workshop are interested in compiling an Australian list of significant karst systems. When there is a profile of potential sites and systems then a plan can be made to implement what is required for formal acknowledgement of karst systems.


PHOTO: ROSS ANDERSON

Some of the root material in a chamber in WI9, WA.

CONCLUSIONS

This paper aims to increase your knowledge on the importance of subterranean wetlands in karst systems. A number of methods and processes are outlined to assist in the recognition and protection of these unique environments. Think about what karst sites you consider to be significant and why. When you get home from this conference, please go and look at the websites that I have referred to. Think about your local karst area and caves sites that you are familiar with. Can you document the karst values of your local subterranean wetlands so that their importance is acknowledged and perhaps protected? Perhaps you could organize or facilitate an event in your local area to raise the awareness of the local community to karst and subterranean wetlands. Perhaps you could organize a display or seminar or information night for one of these events:

- World Wetlands Day – February 2
- National Threatened Species Day – September 7
- Science Week – August 13 to 21, 2005

One author stated that *"underground aquatic ecosystems and their novel fauna… should be given the highest level of protection"* (Hose 2004: 23). What are you doing to assist in protecting the ecosystems that are our karst systems? I heard a statement that *"caves are the books in the library of the history of the earth".* As cavers we regularly visit a large number of these special libraries. We know where the books are and we often have documented in great detail the contents of each book.

However, in many cases the librarian does not know that a particular book exists or even how many books are on a bookshelf. The librarian may never have seen the book that we are so familiar with. They may not know the book's value or the important information that it contains. So let us go and talk to the librarian to make sure that these books do not get lost and that their value is protected for future generations. ■

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KARST MANAGEMENT IN WA
– AN OVERVIEW OF THE CURRENT SITUATION

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ABSTRACT

There are a range of environmental management techniques, laws and policies that have been directed towards protecting and conserving some aspect of the environment. The conservation and protection of karst systems is an important issue that needs greater consideration and attention. The development of management plans and policy can play a significant role in the protection and conservation of karst systems. The state of W.A. has many karst systems, with differing land tenure. As such, these areas also have a wide variety of karst management. The areas within Western Australia which are karstic include: the Nullarbor, the Kimberley Region, the Cape Range, and the south-west coastal calcarenites – including the Wanneroo cave belt near Perth, and the Leeuwin-Naturaliste Ridge.

This paper will briefly examine the range of instruments that are available in relation to protection and conservation of all aspects of karst systems. The paper will outline the policy instruments relating specifically to karst systems that exist in Western Australia. The focus of the paper will be on wholistic karst management and management techniques currently being utilised, on a regional basis. The final Section of this paper will examine the effectiveness of current management techniques and policy and make some recommendations for future direction.

There is an opportunity for the Commonwealth and State Governments to set some clear policy regarding karst systems. It would be excellent if the agencies and organisations could work together in the management of karst. It is encouraging to see the progress that has been made, however there are opportunities for the development of further important policies in an integrated manner regarding this significant environmental issue. There is also further opportunity for both the public and the government to be involved in protecting and conserving karst systems. It is the author's view that karst management in WA could benefit from increased collaboration and consultation. There is also a need for more education and interpretation of karst areas.

INTRODUCTION

As an ASF member, my interest in caves has broadened from the protection of caves (and their ecosystems and specialized fauna) to karst management in general. In my role as a WA Conservation Commission Co-convenor I have been able to represent speleological groups on a number of committees. This led me to further my interest in karst management by undertaking postgraduate study (in karst management). Recently I undertook a subject titled "Protected Area Policy". As such, I have examined research on environmental policy and karst related policy. The major policy instruments are outlined here to assist in raising your awareness of the topic in general. I hope that, by the examples I provide, you will be challenged to find out about your state and karst area.

If you are unfamiliar with the concepts of environmental policy or Australian legislative responsibility then I suggest you find out more. I would be happy to provide some useful references or point you in a direction. Basically, the State governments have the principal legislative responsibility for natural resource management – developing legislation, policies, standards and guidelines.

The Environmental Defender's Office (EDO 2001) outlined that environmental law is derived from five sources – common law, statute, subsidiary legislation, administrative policies and international law. Although not laws themselves, policy and administrative guidelines are important. Statements of planning policy are examples of policies and guidelines that affect the way that law is practically applied. Policy is also important in that it can drive implementation of legislation.

There isn't the time to deal with each aspect in great de-

PHOTO: CAMERON ELDRIDGE

One of several karst features in a significant karst system at risk of damage due to a lack of appropriate policy regarding karst systems in W.A.

tail, so this paper is a preliminary presentation of the main policy instruments in relation to karst management in WA. A list of the Commonwealth, national and local policy instruments is in Appendix A. Aside from specific 'karst' policy – aspects of karst can be covered under environmental policy categories – ie the flora, fauna, water may obtain protection from other avenues. Appendix B outlines some of these other policy instruments that may relate to WA karst systems.

THE ISSUE – PROTECTING AND CONSERVING CAVES AND KARST

Caves occur in a range of geological areas and have a broad range of definitions (Jones et al 2003). Generally the majority of caves occur in karst. The term "karst" has been described by several authors to refer to a special type of landscape that is commonly characterized by caves, subterranean drainage and closed depressions. It is known that karst landscapes are formed primarily by the solution of rock, most commonly limestone (Gillieson 1996). Other authors emphasise the complex and integrative nature of karst by referring to a karst system as incorporating component landforms as well as life, energy, water, gases, soils and bedrock (Yuan 1988, Eberhard 1994). Thus karst is a result of a complex interplay between a number of complex factors – These include: geologic, pedologic, climatic, topographic, hydrologic, biologic and temporal factors (Hamilton-Smith et al. 1998).

Some of the most recognized attributes of karst are caves and underground streamways. Some authors refer to surface and subsurface components of a karst system. However, the key concept is that of a unified system that is dynamic, interactive and interrelated. Yuan (1988) outlined how karst systems are difficult, if not impossible, to restore once degraded. Thus these environments need a range of policy instruments developed to protect them.

Water plays a key role in karst systems. Kiernan (1998) explained that the cornerstone of successful karst management is a recognition of, and successful response to, the need to maintain the natural regime and quality of the fluids that flow through karst (both the gases and liquids). Hamilton Smith et al (1998) further added that the *"quality of any karst environment is most importantly dependent upon the integrity of the catchment and aquifer"*: (1998:39).

Examples of areas within Western Australia which are karstic include: the Nullarbor, the Kimberley Region, the Cape Range Province in the Exmouth area, and the coastal calcarenites – including the Wanneroo cave belt near Perth, and parts of the Leeuwin-Naturaliste Ridge.

Subterranean fauna are a special feature of karst systems. The Department of Environment (DOE) (2004) outlined some of the issues associated with karst areas in W.A. The DOE also provides an excellent outline of some of the threats to the environmental values of karst.

ASPECTS TO CONSIDER

Many people think of caves as a discrete environment that is 'there' for some aspect of their recreation. The majority of Australians would have visited a tourist cave and can easily relate to the beauty and aesthetic value of karst environments. However, within the population there would not be a wide understanding of the importance of karst and the varying reasons for its protection.

Traditionally, humans have had a number of uses for caves and the resources contained within karst systems. Archaeological and palaeontological records indicate sites of historical or cultural significance – art sites, burial sites, habitation sites, water resources or the preservation of materials such as bones. The geological aspect of caves and karst systems also needs consideration. The geological resource, such as limestone, can be quarried and used in industry. The minerals in karst may also have uses to humans. The biological aspect of karst systems also needs consideration – the rock may be a special habitat for subterranean creatures that have adapted to that environment. Karst is also an aquifer and thus an important source of water for many people.

PHOTO: ROSS ANDERSON

Local speleologists examining a subsidence in a new development caused by runoff from a local road.

Therefore, there needs to be a range of policy instruments to cover a variety of aspects within a karst system. As discussed earlier – each aspect of a karst system needs to be considered in relation to the others, as karst is a 'system'. There are a wide number of issues and aspects that need consideration in policy development.

CHALLENGES AND OPPORTUNITIES

As with any environmental issue, there can be a number of challenges and opportunities involved in protecting and managing the natural environment. There is a need to ensure that karst systems are managed in an integrated manner, where the surface and subsurface are considered together. Many karst areas are managed purely as 'surface' environments with little consideration of issues such as surface impacts on the subsurface or of catchments impacting on the system as a whole.

Due to the nature of the issues outlined, and the fragmentation of government agencies, no single government department is responsible for policy regarding karst systems. Some government agencies will have internal policy documents relating to karst, while other agencies will have some statutory responsibility for an aspect of the karst system. There are other agencies that develop karst policy for a particular area in relative isolation or for a particular issue (ie development on a karst area). In the majority of situations, policy on broad issues such as sustainability, vegetation, threatened species and wetlands can also be utilized in relation to karst systems in some areas.

Other challenges involve balancing resource use with resource protection – ie quarrying versus conservation reserves. In some situations a conflict in land use may arise – such as infrastructure or housing development in a karst area versus agricultural use or conservation of the area. Other conflicting uses can be that of recreational caving within a karst system

– ie in a national park. Not only are there access issues ('who' can access 'what') but also visitor impact issues. Other issues such as vandalism, damage or visitor risks are issues that need consideration in policy development, implementation and evaluation. Thus the areas of conservation of the specific environmental issue will inter-relate with recreational issues, tourism, resource abstraction and industrial uses of karst systems. There is an opportunity for both the public and the Government to be involved in protecting and conserving karst systems. There is a need for more education and interpretation of karst areas. There is a need to educate everyone on 'why' these special areas need protection, and also in educating those who manage land (private or government) on 'how' to protect and conserve karst systems. In relation to Australia, a lot can be learnt from looking internationally at how other countries deal with this specific environmental issue in relation to policy.

KARST MANAGEMENT

Hamilton-Smith et al. (1998) stated that 'success' in managing karst depends upon recognition of the need for it to be managed as a total integrated and dynamic system" (1998:3). It could be stated that, in Australia, there is a lack of understanding of what karst is, how it forms, its dynamic nature and why its management needs are so specific. The issues facing both users and managers of karst systems are summarized in more detail in Kiernan (1988). Thus, management of karst systems needs to take into consideration all of the components described previously – the climate, topography, soil, vegetation, catchments characteristics, biology etc,

Specific land management issues in karst areas include: groundwater use; urban use – development and planning – roads housing, infrastructure; mineral use – quarries; cave use – recreational and tourism; scientific research; biology and habitats. It is the author's recommendation that karst areas are managed using styles of management such as an integrated catchment management approach or ecosystem management approaches. Given the need to manage karst systems in a wholistic manner, there needs to be a range of policy instruments available.

RESOURCE CONSERVATION ISSUES

Hamilton-Smith et al. (1998) state that *"the fundamental tenet of karst management is to protect the whole karst hydrogeologic system"* (1998:46). This will require the integrated management of the karst system and its catchment area. Karst areas occur throughout Australia, on a variety of land tenure. In many areas there are many resource uses operating, some of which are potentially conflicting uses. Protecting and conserving karst systems involves more than just a blanket creation of a national park or a reserve over an area. The management of karst areas involves numerous agencies, groups and individuals working together. The development, implementation and evaluation of policy in relation to karst systems play an important role in karst systems management.

It must be acknowledged that there is a great deal not known in relation to a number of karst areas. As such, Hamilton-Smith et al (1998) outline that any planning policies should be conservative in nature, simply because the environmental impacts of mistakes will be difficult or perhaps impossible to correct. Jones et al (2003) outline that cave protection entails considering three aspects: physical contents of the cave, cave life and the hydrological aspects (including catchment). These authors also referred to 'cave protection' as entailing: controlling access to the cave and controlling land use practices (both directly above the cave and in the entire watershed). Thus is can be seen that there are a wide range of issues that need to be considered when policy instruments are utilized, developed and implemented for caves and karst systems.

KARST RELATED POLICY

On an international level, there are well-developed bodies of policy and practices relating to conserving and protecting caves and karst systems. In particular the IUCN guidelines (Watson et al. 1997) are a useful document that is specifically relating to protecting karst systems. I hope that all cavers are familiar with the IUCN "Guidelines for cave and karst protection". It outlines that *"the establishment of protected areas is not, in itself, enough to ensure karst protection"* (1997:16). Additionally, the guidelines stress that *"more than in any other landscape, a total catchment management regime must be adopted in karst areas"* (1997:20). You may be familiar with the term integrated management or integrated catchment management. As cavers and speleologists, we need to keep in mind that this is what is required for management of karst systems.

At an Australian level however there are no specific Federal policy instruments in relation to karst systems. At a State level, there is no legislation or complete policy instrument that deals with protection or conservation of caves and karst systems. There are fragmented policy documents at an administrative level only – dealing with a particular aspect of a karst system. Some policy documents exist to deal with one specific karst area. Appendix A contains a list of the Federal, State and local policy instruments that are relevant to the protection and conservation of caves and karst systems – particularly with respect to caves and karst systems in Western Australia.

Commonwealth

The Commonwealth Constitution gives specific law making powers to the Commonwealth Parliament. The Commonwealth Government plays an important role in environmental regulation – especially in control of interstate and overseas trade and external affairs. A major development in commonwealth environmental law making was the passage of the *Environmental Protection and Biodiversity Conservation Act* (EPBC Act) in 1999. The other paper that I present at this conference outlines this in more detail (Anderson 2005). I encourage cavers to be familiar with the EPBC Act.

State

In the State of WA there are a wide range of government agencies involved in policy development and implementation regarding conservation of karst systems. As discussed in the introduction, each of these agencies will play differing roles, depending on their level of responsibility. The Commonwealth institutions have overall legal responsibility and have developed a number of policies. Implementation of these policies is by State agencies. At another level, the State agencies develop policy. In WA, for example, regarding wetland conservation, this would primarily be the Department of Conservation and Land Management (CALM) and the Department of Environment (DOE). However the other government departments listed also have involvement: The WA Planning Commission (WAPC) and the Environmental Protection Authority (EPA). At a more regional level are the local governments – such as the City of Wanneroo and the Shire of Joondalup.

A quick Internet search by the author gave several direct statutory references in WA to caves or karst. There are no statutes containing the word 'karst', but the word 'cave' appeared several times – primarily in the State legislation under the *CALM Act 2002.* Part 2 of the CALM Regulations 2002 titled 'Protection of the Environment' (S14, S29, S39, S49, S75 and Division 7) relates to caves. Prior to the implementation of this legislation, caves had some reference in statute under the *Parks and Reserves Bylaws Act 1972* (Pt 4, Pt 15, Pt 17). These policy instruments relate to consequences for unauthorized access to caves, smoking in or damage to caves. In particular, a specific land tenure type is covered by these documents – caves and karst on CALM land.

Other references relating to 'caves' were in regard to sections of land that had been reserved. In WA, there are several Acts that are relevant to environmental protection and conservation. These are listed further in Appendix B.

Once example of policy in relation to water (that has some relation to a specific karst area) is that of the Gnangara Mound and the karst system north of Perth. The EPA has been in the process of evaluating policy in relation to water resources. The Draft Environmental Protection (State Groundwater) Policy 1998 is a policy instrument that was prepared by the EPA for public comment but its implementation has been delayed pending amendments to the *Environmental Protection Act.* This policy provides a framework for avoiding degradation of groundwater quality and quantity throughout the State.

The WA Planning Commission (WAPC)

The WA Planning Commission (WAPC) is part of the Department of Planning and Infrastructure. The WAPC prepares and adopts statements of Planning Policy (SPP) under statutory procedures set out in Section 5AA of the *Town Planning and Development Act 1928.* The WAPC and local Government must have due regard to the SPP provisions when preparing or amending Town Planning Schemes and when making decisions on planning matters

There are a number of policy instruments – including Statewide, Regional and Metropolitan policy instruments. Statewide policy documents include – State Planning Strategy and Livable Neighbourhoods Strategy. Metropolitan Strategies include Bush Forever. The WAPC also has a policy manual on subdivision and development control policies. The Statement of Planning Policies Amendment 2003 was published to renumber and update a new classification system. Relevant SPP to karst systems include those relating to: State Planning Framework Policy, Environment and Natural Resources Policy, Peel-Harvey Coastal Plain Catchment Policy, Gnangara Mound Crown Land Policy, Basic Raw Materials, Agriculture and Rural land Use Planning, State Coastal Planning Policy and the Leeuwin-Naturaliste Ridge Policy.

There are no SPP relating specifically to caves or karst systems. Some SPP are semi-related in that the areas referred to contain a karst area. This includes the Gnangara Groundwater Protection Policy 11/2003; the East Wanneroo Rural Land Use and Water Management Strategy (LUWM), the Gnangara LUWM Strategy and the Greater Perth (Future Perth) plan. Regional Policies include the Carnarvon-Ningaloo Coast Regional Strategy and the Gingin Coast Structure Plan. Both of these policy documents have a karst system contained within the region being referred to. These documents all have relevance in that a karst system will occur within a region and needs to be considered in policy that is developed. The WAPC Act 1985 is the overarching document in regards to planning issues.

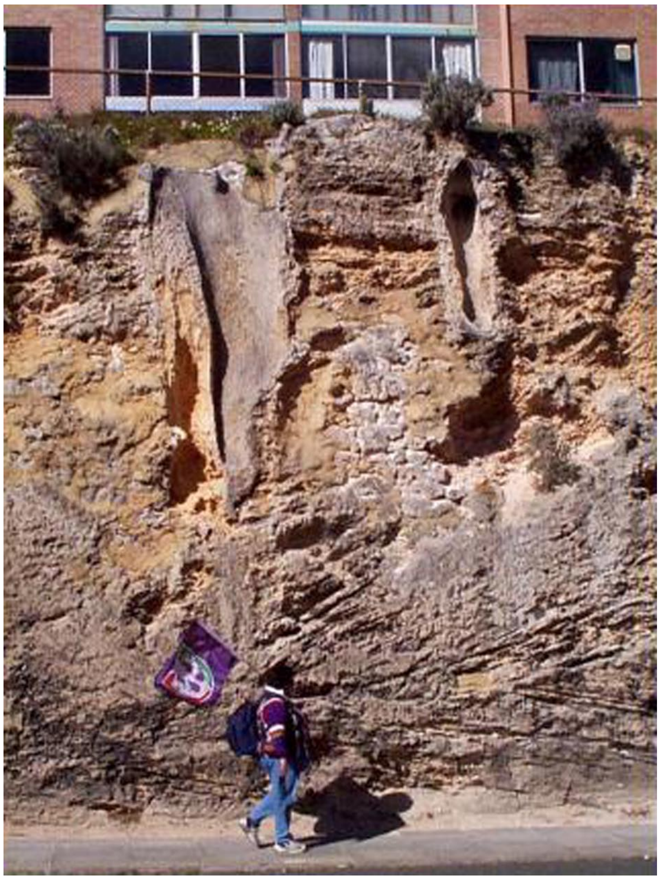

PHOTO: JAY ANDERSON

An example of the close proximity of urban development to karst systems in the Perth metropolitan region.

RECOMMENDATIONS

- That the WAPC develop a specific SPP regarding karst systems.
- That existing SPP – for regions that contain karst – are revised to consider the karst within that region and associated catchment issues.

THE ENVIRONMENTAL PROTECTION AUTHORITY (EPA)

The EPA is an independent statutory authority and is the key provider of independent environmental advice to the WA Government. The EPA's objectives are to protect the environment and to prevent, control and abate pollution. The EPA has a number of policy instruments relating to environmental protection and to environmental quality criteria. There are Environmental Protection Policies (EPP) and Position Statements and Guidance Statements. The EPA published a series of position statements that set out its views on matters of environmental importance. EPPs are prepared in accordance with Part III of the *Environmental Protection Act 1986.* Once approved by the Minister for the Environment this policy has the force of law, as through it had been enacted as part of the Act. Thus, EPPs are statutory policy documents that are required by legislation. There is no EPP in relation to caves or karst systems.

The EPA's most significant policy type of document is a Position Statement. These are principle policy statements. There is not a position statement of karst or karst systems in general. The EPA has developed 8 position statements. The first Position Statement developed was, however, regarding a specific karst area – that of Cape Range (EPA 1999). This document contains sections relating to biological diversity, offshore islands, coral reefs (Ningaloo Reef), landscape, social and cultural aspects and karst and subterranean fauna. The EPA principles regarding environmental assessment and decision-making for the Cape Range Province are significant and the author feels that they should be broadened and related to all karst environments.

Tacey (2004 pers. comm.) outlined that the EPA has not logically developed Position Statements. They have been developed in a 'responsive mode' and by adaptive planning processes – ie as a need arises then a policy is developed. It is the author's belief that these principles should be broadened and applied to karst systems in general. It is clear that the EPA needs to develop a Position Statement regarding karst systems in general.

Guidance Statements (GS) are developed by the EPA to provide advice to proponents and the public about the minimum requirements for environmental management that the EPA would expect to be met when the EPA considers a proposal during the assessment process. (EPA 2004). Tacey (2004 pers. comm.) stated that the GS are quite specific policy documents that list procedures or performance indicators that are required. The EPA has a number of guidance statements. Only one of these relates to karst (EPA 2003). Guidance Statement number 54 is a policy instrument that specifically addresses the conservation of stygofauna in groundwater systems and troglofauna and stygofauna in subterranean caves. The EPA objectives are to ensure the adequate protection of important habitats for these species.

The EPA released a policy document in 1997 titled 'Guidelines for Environment and Planning'. This document is now in the process of being reviewed. The original document did not relate to karst directly or at all. In the last 7 years, the EPA has become more aware of the importance of karst systems and the need to consider this specifically in developing policy instruments. As such, the evaluation of this policy document is now to include a section on karst systems. The new policy is to be titled 'Guidance for Planners in local authorities and State Government'. In February 2004, speleological groups were involved in consultation on this draft document as a specific stakeholder (EPA 2004). This new policy instrument will incorporate aspects on a range of environmental factors – such as vegetation, fauna, wetlands and karst. The Guidance document was planned to be released for public comment around the end of August 2004 (Perry 2004 pers. comm.), however it is still being developed.

RECOMMENDATIONS

- That the EPA develop a specific EPP regarding karst systems.
- That the EPA develop a position statement regarding karst systems.
- That Policy Document 54 be revised to fully relate to troglobitic fauna (currently it specifically relates to stygofauna).

THE ROLE OF LOCAL GOVERNMENT

The Western Australian *Constitution* requires a system of local government to be maintained throughout the State. This is obtained through the *Local Government Act*. Local governments make local laws and develop policy and exercise important powers under the *Town Planning and Development Act* and the *Health Act*. A Regional example is focused on for this section with examples given of policy instruments in the City of Wanneroo (north of Perth).

The City of Wanneroo implemented a local rural strategy in 1999. It contains a section on 'Special Planning Area No.3 (PPA No.3)' 'caves and karstic areas'. There are 7 main policy points and an action cited in this particular policy instrument. Some karst areas may be protected in that they are identified as 'landscape protection' in the Metropolitan Rural Policy 1995 and the North West Corridor Strategy Plan (DPI Policy documents). The City of Wanneroo TPS (and the District Planning Scheme (DPS) No. 2) has some considerations for karst. However, this is a basic, simple document that needs to gain strength from proper implementation. It is recommended that this document be reviewed to consider the karst system as an integrated system. It is also recommended that further reviews of this document include consultation with speleological groups.

As outlined above, there is a wide range of policy instruments regarding the environment, specifically karst systems. The majority of these instruments fall into the category of statute or administrative policy instruments. The extent to which these policy instruments have been evaluated or reviewed varies greatly. Likewise, the extent to which development of policy documents has included speleological consultation.

RECOMMENDATIONS

- That the City of Wanneroo LES document be reviewed to consider the karst system as an integrated system.
- That further reviews of the LES document include consultation with speleological groups.

ANALYSIS OF POLICY

As discussed there is only a small range of policy instruments regarding karst systems in W.A. There are some much-needed alterations and reviews required on current and existing policy documents. The government agencies do not have specific karst knowledge or experience in the development of such specific policy. In the majority of policy development there has been little consultation with speleological groups or with specific individuals who have karst systems knowledge or experience. It is only in recent times that the importance of karst systems has been recognized and that speleologists are becoming more involved in the development of policy and in the public consultation process. It is the author's opinion that there is a lot more 'room for improvement' and that the consultation between government and specialist stakeholder groups (such as speleologists in karst areas) should be more formalized.

The policy in relation to karst areas in WA has only been developed in the last decade – or is still being developed. As such, this is a relatively new field of specialist policy. It would be excellent if the government could look to other countries' policy instruments as an example and to assist in the future development of policy documents.

There are several regulatory instruments in WA. However, these are not comprehensive and do not generally relate directly to karst systems. There are no economic instruments. In relation to establishing protected areas – these occur mostly at a government level with government land. Karst systems are protected in national parks or conservation reserves – this is not a holistic or representative system. The government needs to develop policy instruments to encourage private landowners to establish protected areas on their own properties. In summary, the Government is only really just starting to utilize education as a policy instrument. At a Federal level, Geoscience Australia has recently undertaken a project on 'Karst Hazards' and produced an information booklet. This is a first step on a necessary process of education. Traditionally, speleological groups and environmental/conservation groups have played a large role in environmental education. Thus, there is much more to be achieved with a range of policy instruments.

On the whole, the author considers that there are lots of gaps in policy and plenty of opportunity for developing integrated policy instruments.

There is scope for such policy instruments as economic incentives – taxation incentives or subsidies – ie to encourage landowners to undertake conservation covenants or appropriately manage land and to protect karst systems. In respect of visitor impacts, there is an opportunity for an integrated approach to managing and protecting karst systems in Australia. The government needs to develop appropriate regulatory policy instruments to assist in the protection of the important cave and karst systems.

The author notes that in existing policy instruments, the policy goals have not been clearly stated. The author realises that the regulatory instruments regarding karst primarily exist for the protection of the environment. However, there is a variety of factors involved that make the situation complex. Thus, policy instruments involving planning, development, resource use or recreation may not reasonably be compatible with environmental protection. Thus, the current mix of policy instruments may not be fully effective in achieving policy goals.

FUTURE DIRECTIONS

The WA Conservation Commission 2004 Report to the ASF (Anderson et al 2004) outlines the situation regarding karst management for each WA karst area. In summary, out of all the karst systems, there are a number of issues. Not all of the karst systems are protected with respect to their land tenure. In most situations, only portions of karst areas are contained in national parks. For example – Cape Range National Park (CRNP) and Yanchep National Park (YNP) only contain part of the local karst system. A large amount of karst is Crown land/rangelands/pastoral leases. Other karst systems are on private property. Out of the land that is under State Government control – there is no area with a current and up-to-date management plan. The management plans for the Leeuwin-Naturaliste National Park (LNNP), YNP, South Coast, and CRNP have all expired and are under review. It is important that the management plans take into consideration the karst system.

In addition, there is no policy that requires other land tenure types (with karst systems present) to have management plans or to conserve the natural environment. It seems to be that individuals with caves or karst systems on their private property can do what they like with the ecosystem. This is of concern, as not all significant caves or karst systems are protected appropriately.

The author would like to note that there is no karst area in WA that follows the IUCN principle of total catchment management, or Integrated Catchment Management (ICM). Only two karst areas have some form of regular speleological consultation – the YNP has the Caves Advisory Committee (CAC) while the LNNP has the Cave Management Advisory Committee (CMAC). Both of these advisory committees utilise volunteer speleologists and other community members for consultation on karst management issues. In some situations, the land manager may disagree with the 'advice' given by the committee and make a different decision – in this situation, there is little that can be done if the land manager is making decisions that may be detrimental to the karst system.

Only one karst area in WA has both a management plan with specific karst recommendations, and a manager with karst knowledge or experience. The LNNP has a 'caves manager' who is a speleologist who has obtained a postgraduate certificate in karst management. The management of this area includes regular speleological consultation through the use of the CMAC. This process is considered by the author to be working well. The WA Government needs to implement a similar system for the other major karst systems in WA.

Of particular concern are the karst areas under immediate threat. The caves of the Swan Coastal Plain (including YNP and LNNP) are under threat due to altered environmental conditions. In particular the water in the karst system has significantly decreased over the last 10 years (but also the last 20 years). There are several threatened communities and threatened species found in WA karst systems that may be protected under either State legislation or the EPBC Act. Such communities occur in YNP, LNNP and CRNP. For example there are the Remipede Community, Camerons Cave Community in the CRNP and the Threatened Ecological Communities of the Swan Coastal Plain.

Of particular concern is the effect of urban development (and the Perth metropolitan area) on caves and karst systems that are not contained in national parks. In particular areas of private property are being subdivided. There is a need for legislation and policy regarding planning and development in karst. Likewise, the land and water use in catchments for karst systems needs consideration.

It would be excellent if State Government agencies could work together to develop policy relating to karst systems and to have a specialist karst policy unit, a State Karst Officer or a Karst Education Officer. There is an opportunity for the Commonwealth to set some clear policy regarding karst systems. Also, there is a need for State Governments to acknowledge that managing karst systems requires some different skills and knowledge – due to the unique ecosystems involved. The development of an appropriate mix of policy instruments would be required. It would be excellent if there was a 'Cave Resources Protection Act' such as exists in the USA. It would also be excellent if government agencies could develop a range of other policy instruments in relation to the protection and conservation of caves and karst systems. Although this paper presents some recommendation, more specific detail is contained in the paper under development by the author (in press this volume).

RECOMMENDATIONS

- That the WA Government examine other countries' policy instruments relating to karst, as an example and to assist in the future development of policy documents.
- That the Government develop policy instruments to encourage private landowners to establish protected areas on their own properties, encourage landowners to undertake

conservation covenants or appropriately manage land containing karst systems.
- That there is a system of education regarding karst systems, particularly for the public and local government in karst areas.
- That the Government develop appropriate regulatory policy instruments to assist in the protection of the WA's cave and karst systems.
- That the Government implement appropriate policy instruments and that there are significant consequences for situations where policy instruments are not considered.
- That the WA Government implement a system for each major karst system in WA: where there is a current management plan, a karst manager and appropriate consultation with karst professionals and speleologists.
- That there is a "state karst officer" for Western Australia.

CONCLUSION

This protection and conservation of karst systems is a complex issue. There are a wide range of factors involved. This paper has examined the range of policy instruments that are available in relation to protection and conservation of all aspects of karst systems in Western Australia. The development of future policy can play a significant role in the protection and conservation of karst systems. It is excellent to see the progress that has been made, however there are opportunities for the development of further important policies in an integrated manner regarding this significant environmental issue. ■

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Appendix A

List of Federal, State, and local policy instruments

1. COMMONWEALTH

a. Legislation

- *Environmental Protection and Biodiversity Conservation Act 1999*

b. Broad Policy Documents

- Intergovernmental Agreement on the Environment – 1992 (IGAE)
- National Strategy for Ecologically Sustainable Development (ESD) - 1992
- National Strategy for Conservation of Australia's Biological Diversity - 1996
- Australian Heritage Commission Principles — ie the Natural Heritage Places Handbook and the Protecting Local Heritage Places document.
- The Burra Charter – The Australian ICOMOS charter for the conservation of places of cultural significance. I.C.O.M.O.S. Conservation Principles – 1988 & 1999
- Australian Natural Heritage Charter - Australian Heritage Commission
- The Richmond Communique: Principles and Guidelines for the Management of Australia's World Heritage Areas. Australian Committee for the IUCN.

2. STATE – W.A.

a. Legislation

- *Parks and Reserves Bylaws 1972*
- *Reserves Act*
- *Reserves and Road Closure Act Amendment Act 1978*
- *Town Planning and Development Act 1985*
- *Wildlife Conservation Act 1950*
- *Environmental Protection Act 1986*
- *Conservation and Land Management Act 2000*
- *Mining Act 1978*

b. Broad Policy Documents

- State Sustainability Strategy
- WAPC – SPP
- EPA – Draft Environmental protection (state groundwater) 1998
- EPA – Swan Coastal Lakes Policy
- DPI – Draft SPP 2.2 – Gnangara Groundwater Protection Policy
- Metropolitan Regional Scheme Amendment 1036/33 – Gnangara Mound Groundwater Protection

c. Specific Policy Documents Relating to karst systems

- EPA –Guidelines for Environment and Planning
- CALM – Policy on Tourism
- City of Wanneroo – Interim Local Rural Strategy
- EPA – No 54 – Sampling of subterranean fauna in groundwater and caves

d. Local and Regional Policy Documents

- LNNP – Permit system and CLAP (Cave Leader Accreditation Panel)
- Specific Regional Land Management Plans that involve karst areas (Yanchep NP, Cape Range NP, Nambung NP, LNNP NP etc)
- Report prepared for WA DEP – Hamilton-Smith et al 1998 – Cape Range.

Appendix B

Policy Instruments- Regulatory/Statutory relating to Environmental Protection & Conservation – in W.A.

1. National Parks and Nature Reserves – the land, flora and fauna.

Controlled and managed by the Department of Conservation and Land management (CALM) under the *Conservation and Land Management Act* and the *Wildlife Conservation Act.*

2. Heritage

The protection of natural and cultural heritage is dealt with by the *Heritage of Western Australia Act, National Trust of Australia (WA) Act* and the local town planning schemes.

3. Planning

This is chiefly governed by the *Town Planning and Development Act* and the *Western Australian Planning Commission Act.* These policy instruments set out procedures for making State, regional and local planning schemes and strategies.

4. Environmental Impact Assessment

Provision is made under the *Environmental Protection Act* for the environmental impact assessment of proposals that have the potential to have a significant effect on the environment.

5. Threatened Species

Native species of flora and fauna are protected under the *Wildlife Conservation Act* and managed by CALM under the control of the *Conservation and Land Management Act.* Flora that is on Crown land is protected under the *Land Administration Act.* Certain aquatic species and their environments are protected under the *Fish Resources Management Act.*

6. Soil and Land Conservation

This is covered by the *Soil and Land Conservation Act, Country Areas Water Supply Acts,* the *Environmental Protection Act* and the *Town Planning and Development Act.*

7. Water

A number of Acts cover water quality and usage. The *Rights in Water and Irrigation Act,* the *Metropolitan Water Supply, Sewerage and Drainage Act,* the *Waterways Conservation Act,* the *Environmental Protection Act.* Other relevant statutes include the *Soil and Land Conservation Act,* the *Country Areas Water Supply Act,* the *Health Act,* the *Land Administration Act* and the *Fish Resources Management Act.*

A. Wetlands, watercourses, surface waters and groundwater managed by the Water and Rivers Commission – now part of the Department of Environment, Water and Catchment Protection.

POSTER

THE DESTRUCTION OF THE HARMAN VALLEY, VICTORIA

Ken Grimes
Regolith Mapping, PO Box 362, Hamilton 3300

Reto Zollinger
33 Forster St, Hamilton, Victoria 3300

PHOTO: KEN GRIMES

Bulldozers in action in the Harman Valley.

ABSTRACT

A significant lava flow on the slopes of Mt Napier has been degraded by the actions of the landowner in bulldozing the basalt, crushing the rocks and altering the nature of the landscape. This is a serious conservation issue and this poster outlines the implications and raises some legal and management issues.

KARSTCARE
– CAVERS LOOKING AFTER CAVES AND KARST

David Wools-Cobb
PO Box 20 Ulverstone TAS 7315


PHOTO: GARRY K SMITH

Jessica Wools-Cobb in the Pleasure Dome.
Photo Competition First Prize for a Print in the Passages category.

INTRODUCTION

KarstCARe is a group made up of active cavers in northern Tasmania who are interested in contributing to the management of caves in the Mole Creek Karst National Park. Each KarstCARe participant is a member of Wildcare, which is the largest incorporated environmental group in Tasmania. Wildcare has existed since 1998 and is a community partner organization with our "Parks Department". Wildcare has several different sections: Adopt-a-track, Heritage Care, Fishcare and Community Action in Reserves. (C.A.R.). C.A.R. groups concentrate their efforts on specific national parks or reserves. Wildcare members work alongside staff of DPIWE and the Parks and Wildlife Service, but the organisation sits outside the Parks Department.

Membership of Wildcare is $25 per year and these funds stay within the organization to help fund projects. Most projects are joint Parks & Wildlife Service/Wildcare projects, with proposals for funding going to the Wildcare board with Parks backing and support. Members receive a regular *Wildtimes* newsletter bringing news of past achievements, conferences, meetings and planned projects, and also receive discounts from supporting businesses and a substantial discount on the annual National Parks Pass.

Wildcare has its own insurance, regrettably an important necessity in current times. The insurance premium is paid by Wildcare to cover members who are undertaking any Wildcare-approved work. All working bees must be authorized by the organization, with strict guidelines as to the type of work, how it may be supervised, what equipment may be used, etc. A "CARes" group in consultation with a Parks Ranger usually initiates a project. Wildcare must be notified before any work is undertaken, with a list of participants and full details of the project or Parks staff may call a specific working bee.

KarstCARe is a CARe group focussed on the Mole Creek Karst National Park. We work directly under the Parks Office at Mole Creek. Our structure is somewhat casual, with a President, who I prefer to call a coordinator, and various volunteers from both within caving clubs and cavers not aligned with a club. We have so far contributed about 500 hours of "hands-on" work in the past 4 years.

The President's role is liaison with Parks staff to discuss projects and coordinate volunteers and equipment. He also arranges all administration with Wildcare, such as working bee call-ups and activity notification. He also ensures proper registration of each volunteer for each activity to ensure insurance cover.

One of the most difficult tasks for the President is the raising of funding for projects. This can be from within the Wildcare organization itself, from various Government-based environmental bodies or even from corporate bodies. Although most of our work is labour-based, funds are required for such things as cleaning equipment, ropes for access and even track-markers. Parks sometimes assist with such equipment but often volunteers provide their own.

ACHIEVEMENTS SO FAR

Kubla Khan

The access track has been cleared to ensure a definite route, limiting damage to the surrounding bush land. Within the cave, about 130 kg of mud was removed from "de-trog" rock, an area used to prepare for a visit to the Pleasure Dome area. All cavers remove their outer trog-suit, boots, socks and anything else dirty before stepping across to an enormous flowstone area which is arguably the most spectacular in this cave. By cleaning the access and the area itself, and placement of matting, further mud transfer has been virtually eliminated. Much of the standard route through the cave has been cleaned; however some sections are more difficult than others. This is an ongoing project with conference participants who wish to visit this cave able to make a contribution.

The Sally's Folly work-site is 3 hours travel form the surface - probably one of the more remote sites for a working bee. At this site our group cleaned down a flowstone climb revealing micro-gores under the mud, installed a new boot-washing station limiting further mud tracking and cleaned a slippery climb, which is part of the route.

PHOTO: DAVE WOOLS-COBB

Changing the water at a boot washing station in Kubla Khan Cave.

Boot-washing stations are positioned throughout Kubla Khan Cave. If used properly, they are an effective method of limiting further mud tracking on to previously cleaned areas. These stations need periodic maintenance to remove accumulated mud and to top up the water (sometimes from several hundred metres away).

Tailender Cave

We carried out a line survey over 2 days, instituted track marking and placed some advisory signs and stringlines on "no-go" areas. We also achieved extensive cleaning.

Assistance with water-tracing

Our group was able to assist with local knowledge in an NHT project involving the hydrology of the Mole Creek area, including the placement of charcoal collection bags to determine stream flows in a particular valley.

Mersey Hill

This is an area of land purchased by Parks to incorporate into the Karst National Park. Unfortunately this block has been infested by a weed - Spanish Heath. As the land is just above the Mersey River, it was considered that there was a risk that this weed would spread to adjacent areas and downstream.

Two environmental groups had already worked on this site before KarstCARe held a working bee to poison more plants. Painting poison on plants seems an unusual activity for cavers but it was our highest-ever attended working bee! We finished off that day with a site visit to Mersey Hill Cave to examine future cave management issues.

Croesus Cave

It is probably the 'second most' spectacular cave in the Mole Creek area, with a spectacular flowstone feature named "Golden Stairs". In past times the land management group, the Government Forestry Department had installed an inflated dinghy to bypass this area.

This led to extensive marking of the landing point, so the boat was removed. This resulted in all cavers having to walk over the Golden Stairs (which is self-cleaning) but at the top was a muddy pool with the route continuing across more flowstone. We built a rock walkway from surrounding rocks to prevent picking up mud and tracking it further. We also cleaned the area and further upstream for another 100 m.

Marakoopa Tourist Cave

We spent a day removing all "non-cave" material possible from the tourist sections. Apart from minor public litter, many old electrical installations were still lying around, plus other old construction materials. In total, four large garbage bags were filled with rubbish.

The most interesting find was a very old "Milo-type" tin with candles and a few old-style light globes. Countless broken light globes were also removed.

CaveMania Post-Conference Project

Our methods have to be innovative at times - for instance, for the preparation for the CaveMania project in Kubla Khan, water has been stored in swimming pools over the past winter season (as there are no reliable water sources in the area through summer).

KarstCARe has conducted a number of working bees in Kubla Khan to set up this project to store water, install fixed rigging, track-mark and delineate areas to be cleaned. KarstCARe's aim is to have a totally clean route right through Kubla Khan Cave wherever possible. This route totals about 3000 m in length. The Kubla Khan project for January 2005 involves cleaning between 140 and 160 metres of the route. All conference participants who have competent vertical skills will be able to join a trip into or through Kubla Khan provided they are prepared to work for two hours or so. Knowing how popular the cave is with visitors we hope to achieve a great deal.

PLANS FOR THE FUTURE

Later in 2005 we are planning a "delicate" cleaning job in Croesus Cave to undo damage done some 30 years or so ago before the cave was gated. Plans are also underway for extensive trackmarking in some of the non-tourist sections of Marakoopa Cave. Our task in the future will involve assisting Parks staff in the more difficult areas. Our guiding principle is to undo previous damage done by cave visitors and assist in managing caves to minimize future damage. Much of our work is tough – it sometimes involves standing in water at 2°C while scrubbing flowstone with a brush! Many or our sites are difficult of access, but then who better to work in a cave than those who "naturally" feel comfortable in such an environment?

WHAT CAN KARST MANAGERS DO?

It is important to involve speleologists/cavers in cave and karst management especially as they are often the people who have found the caves, surveyed and documented them. I feel we should not judge either past practices of cavers or cave managers using today's values. By using the expertise of cavers, managers can undo some past damage and institute management principles (such as track marking, bootwashing stations) to limit future damage to caves. By developing relationships with cavers in a particular caving area, managers can tap into local knowledge and expertise. Cavers usually welcome the opportunity to have an input into management decisions. We all care about caves, so with managers and cavers forming a partnership we can work together for the good of caves and karst. ■

THE TSINGY DE BEMARAHA PINNACLE KARST OF WESTERN MADAGASCAR

Arthur Clarke
School of Zoology, University of Tasmania, Private Bag 05, Hobart, Tasmania 7001

PHOTO: ARTHUR CLARKE

View towards Belvedere, Tsingy de Bemaraha, western Madagascar.
Photo Competition Second Prize for a Digital photograph in the Entrance and Other Surface Features category.

Originally part of the African mainland and super continent of Gondwanaland, Madagascar is now an island country - the fourth largest island of the world - located 400km east of Mozambique (in Africa) and around 400km west of the small islands of Mauritius and Reunion. Known for its amazing biology, particularly the diverse mix of arid and wet zone flora with many unique animals (50 species of chameleons and 22 species of lemurs), Madagascar also has some world-renowned areas of unique limestone pinnacle karst.

Pinnacle karst is a form of tropical or equatorial karst characterised by near vertical rock blades, fretted and sharpened by dissolution. Principally dissolved by rainwater there are three described forms or varieties of pinnacle karst: shilin (in China), the arete karst in Mulu (Sarawak) and the New Guinea Highlands and the most acute form: the tsingy karst of Madagascar.

The Tsingy de Bemaraha Parc Nationale is one of two large areas of extensively eroded pinnacle karst located in the arid parts of Madagascar; Bemaraha is in the west and Ankarana in northern Madagascar. The 152,000 hectare Tsingy de Bemaraha Parc Nationale contains two separate areas of limestone: the low relief "Petits Tsingy" adjacent to the Manambolo River and the more extensive higher relief "Grands Tsingy" further north where the limestone pinnacles are in excess of 100m high. Formed as a plateau, this pinnacle karst area features bare reticulated saw-topped ridges with almost vertical slopes rising above forest-covered depressions, fault graben canyons and solution joint corridors.

The surface vegetation in the Tsingy itself is quite unique with many endemic xerophytic and/ or water storage plants. Although the Tsingy receives torrential downpours in the wet season, very little water remains on the surface and in the dry season, the only moisture for 6-7 months is the nightly dew, so it is essentially an arid environment.

The limestone has been structurally altered over time, as evidenced by faulted sections (uplifted massifs of limestone and down-faulted grabens) and strong jointing, giving rise to the presence of maze structures with many narrow fissures. There are three types of caves and correspondingly different cave ecosystems: diaclase maze canyon rifts (essentially 'roofless caves') with many tree roots and a predominance of epigean species; caves with intermittent streams containing occasional tree roots and a mix of hypogean and epigean species and the more extensive caves with speleothem deposits, white walled maze passages and large chambers, sometimes containing thousands of bats and a predominance of hypogean species including guanophiles. ■

KARSTIC PHENOMENA IN THE NAMAKABROUD AREA OF NORTHERN IRAN

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Bahar Firoozi, Kh.,
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ABSTRACT

This paper describes the Madouban Mountain karst area in northern Iran. The geomorphology of the area is examined. Karst landforms are found to be strongly influenced by lithological variations, joint and fault patterns and the effects of dolomitization. Karst development has taken place in the Lar and Tizkuh Formations of Upper Jurassic and Lower Cretaceous age respectively. Their stratigraphy is discussed.

Karst development is characterized by the presence of caves and dolines and many springs are found in the northern foothills.

To investigate the presence of percolation zones and solution cavities, geological mapping is combined with geomorphological and structural analysis. Geophysical techniques (Schlumberger method) are applied to identify the presence of solution cavities and permeable zones. Our study enables us to describe the patterns and directions of underground drainage and makes a

INTRODUCTION

Madouban Mountain is located near the town of Namakabroud (36°40'N, 51°17'E). The town is found in Mazadaran Province and is located 12 km to the west of the coastal city of Chalus (Figure 1) on the Namakabroud Plain. The plain separates the northern slopes of Madouban Mountain from the Caspian Sea. The town relies on numerous wells for its water supply but excessive pumping has caused salinity problems. Springs in the foothills of Mandouban Mountain provide a source of groundwater for the coastal plain.

STRATIGRAPHY

Geological mapping has shown that the main outcrops of the area are limestones of the Lar Formation (Upper Jurassic) and Tizkuh Formation (Lower Cretaceous) (Figure 2). The two formations are difficult to distinguish because they are rather similar and the thick forest makes field mapping difficult. The Lar Formation consists of an alternation of white, pink, cream and buff coloured layers. It is divided into five sub-units whose characteristics are shown in Table 1. The following biofacies are found in the Lar Formation: *Nautiloculina* sp., lituolids, miliolids, *Oolitica* sp., *Pseudocyclammina* sp., *Cristellaria* sp., *Haplophragmium* sp., textularids, gastropods, pelecypod fragments, *Salpingoporella* sp., *Acicularia* sp.,valvulinids, *Cylindroporella* sp., ostracods,bryozoa, crinoids, echinoid spines and *Dasycladacea* algae.


PHOTO: JULIA JAMES

Saied Hakimi Asiabar delivering his paper.

Sub-unit	Texture (Folk-Dunham)	Weathered Colour	Fresh Colour	Allochems
1	Biosparite (Bioclastic Lime Grainstone)	Black purple	Pinkish grey	Oolith, Pellet, Intraclast
2	Biosparite (Bioclastic Lime Grainstone)	Greenish grey	Creamy grey	Oolith, Pellet,
3	Algal & Gastropod Biosparite (Algal & Gastropod bio-clastic Lime Grainstone)	Greenish grey	Pinkish red	Oolith, Pellet, Intraclast
4	Biosparite (Bioclastic Lime Grainstone)	Greenish grey	Grey	Oolith, Intraclast
5	Biosparite (Bioclastic Lime Grainstone)	Pink to red	Pinkish grey	Oolith, Intraclast

Table 1: Characteristics of sub-units of the Lar Formation in the Namakabroud area.

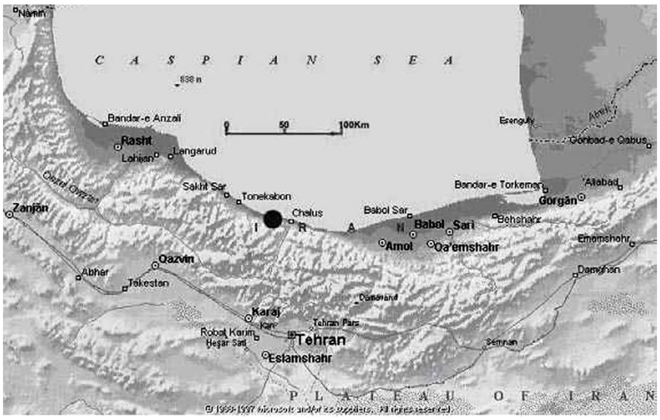

Figure 1: Locality map with dot indicating the location of the Namakabroud area.

Porosity of the beds has been affected in various ways by open space infilling, cementation, dolomitization, recrystallization, the development of vughs, fissures and solution cavities.

Sub-units 4 and 5 of the Lar Formation and the *Orbitulina* grey, thick-bedded limestone sub-unit of the Tizkuh Formation show more evidence of solutional processes than the other sub-units.

GEOMORPHOLOGY AND HYDROLOGY

The study area can be divided into two parts (Figure 3):

- The Namakabroud coastal plain adjacent to the Caspian Sea.
- The Madouban Mountain area to the south which forms part of the central Alborz mountain belt and has a topographic gradient of between 28 and 32 degrees. The uppermost parts have a subdued topography and are characterized by numerous dolines (Figure 4).

Uplift along the Namakabroud thrust fault has created a topographic contrast between the coastal plain and Mandouban Mountain. This thickly forested mountain is located between the Namakabroud and Sardabroud Rivers. The rivers are strongly incised and provide good exposures of the Lar and Tizkuh Formations. There is little outcrop of bedrock in the forested areas.

Mass movement and solutional processes have shaped the local topography. The largest collapse doline on the northern flank of Madouban mountain is u-shaped and is about 600 m long and 250 m wide. Dive-Hamman collapse doline is the deepest surface collapse feature. It is 100 m deep and 80 m in diameter and has near-vertical walls. It is located towards the western end of the mountain. Dolines may show slickensided walls and contain many fresh tree trunks suggesting that collapse has been recent and is actively continuing.

This is also supported by ongoing collapses of both

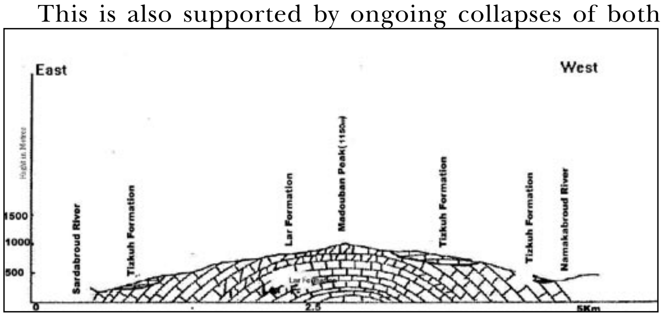

Figure 2: Geological E-W cross-section with limestones of the Lar Formation (Upper Jurassic) and Tizkuh Formation (Lower

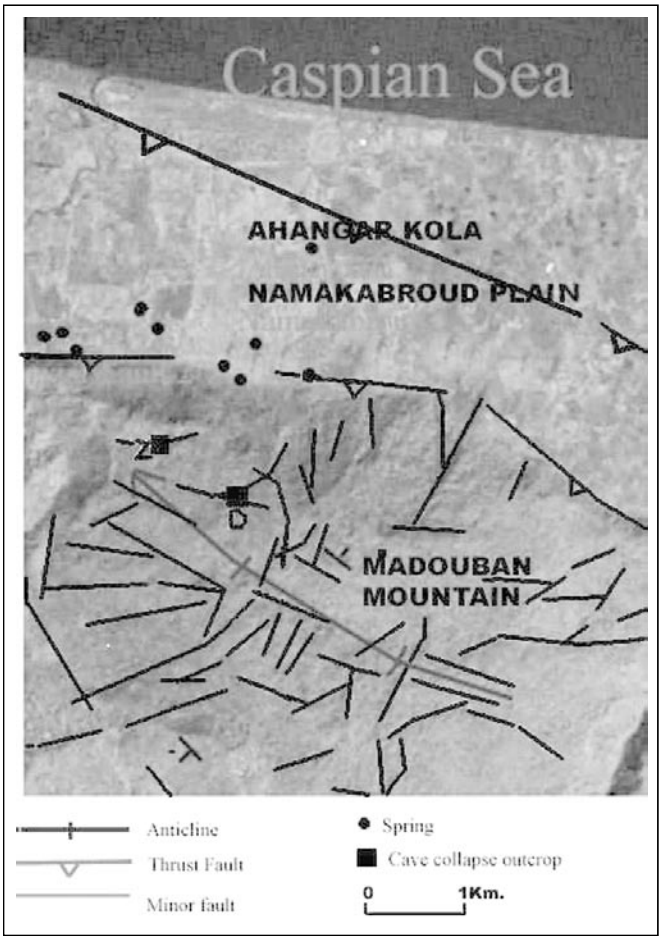

Figure 3: Aerial view of Caspian coastal plain and Alborz Mountain Range

bedrock and soils. Zang-e-Tool and Sisara Caves are found near the mountain crest and provide good examples of cave development.

STRUCTURAL GEOLOGY

The rocks of Madouban Mountain are folded into an anticline with a NW-SE trend and plunging at an angle of 12° to 15° towards N60°-65°W. On the northern flank of the mountain the strata dip at 28° to 32° to the north. The angle is similar to the surface gradient.

A variety of joint and fault sets are seen on Madouban Mountain. Joint spacing is highly variable with an average spacing of 30 to 60 cm. Joint planes are rough and because of the high rainfall generally contain some water. Analysis of aerial photographs shows the presence of three sets of joints, faults and lineaments. They are:

- Parallel to the fold axis.
- NE-SW trending lineaments perpendicular to the fold axis
- Diagonal to the fold axis.

Many sinkholes are located on lineaments and are ellipsoid in plan with the long axis parallel to the direction of lineaments.

The principal fault associated with the Namakabroud coastal plain is the deep-seated Khazar thrust fault. Resistivity data indicate that the fault passes north of the village of Ahangar Kola and is covered by sediments (Figure 3). One branch of the fault separates the coastal plain of Namakabroud from the northern flank of Madouban Mountain and trends W-E while dipping in a southerly direction (Figure

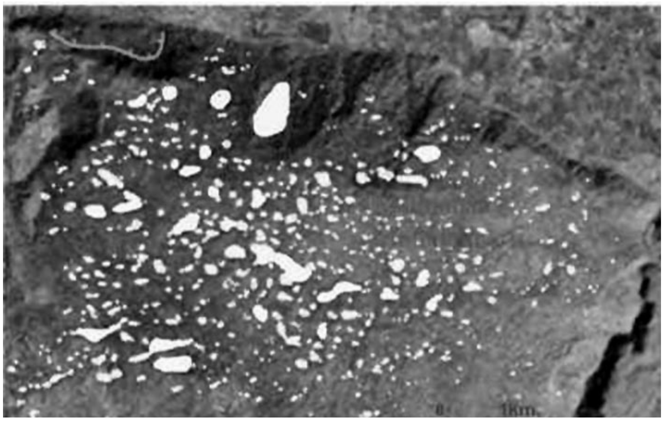

Figure 4: Karstic zone of Madouban Mountain with the Great Landslide shown in top left corner

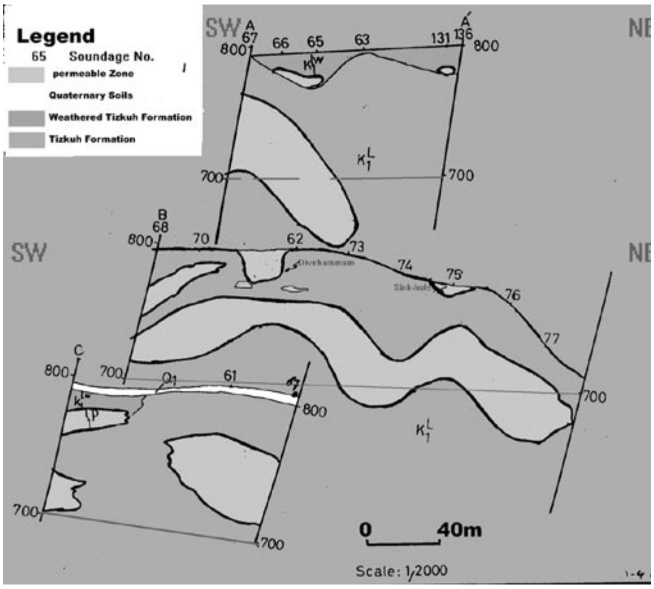

Figure 5a: Geophysical profile of Divehammam area with SW–NE trend

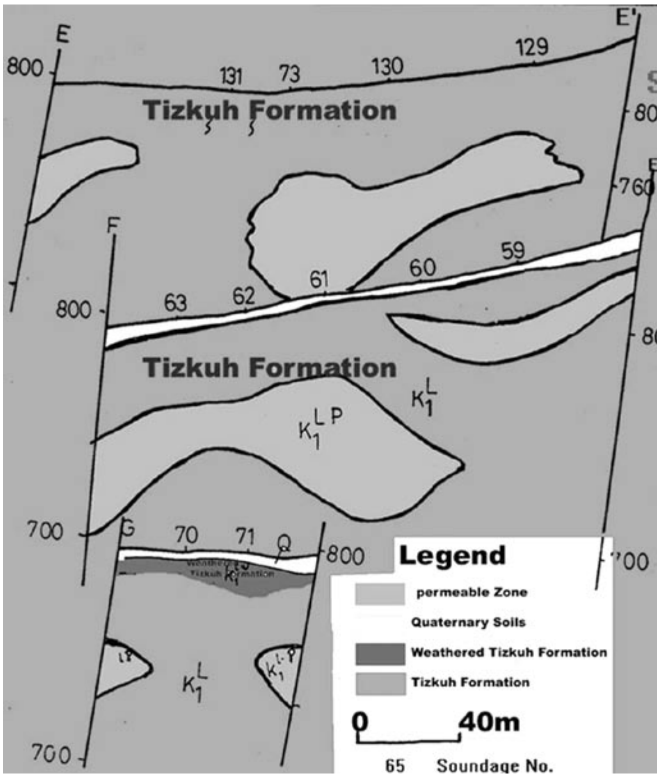

Figure 5a: Geophysical profile of Divehammam area with SE–NW trend

3). This fault is called the Namakabroud Thrust Fault and is marked by a large topographic discontinuity that follows the northern edge of the mountain coinciding approximately with the 1000 m contour.

In the western region of Madouban Mountain, near the Namakabroud River, a spectacular area of mass movement is found that is approximately 1200 m in length and 200 m in width (Figure 4). Solution processes concentrated at the western extremity of the anticlinal hinge appear to have created underground cavities that have played a major role in initiating the landslide.

GEOPHYSICAL STUDIES

Geophysical studies have been carried out to analyze the location of solution cavities and permeable zones. These methods have used resistivity measurements (Schlumberger method) based on an electrode spacing of 1000 m. Permeable zones are characterized by very low resistivity and cavities by very high resistivity.

Figures 5a and 5b show resistivity profiles around the Dive-Hamman collapse doline. Permeable zones were identified in the Lower Cretaceous *Orbitolina* limestone and units of the Upper Jurassic Lar Formation (Figure 6). Many underground cavities in Madouban Mountain show a relationship with surface collapse features.

DEVELOPMENT OF KARST PHENOMENA

The most important factors favouring karst development are the calcareous nature of the rocks making up the Lar and Tizkuh Formations and the mild and humid climate. Karst development has been initiated in beds of high primary permeability but cave enlargement has been strongly influenced by the geological structure. A large number of faults and lineaments are aligned parallel to the axial trace of the Madouban anticline and have promoted the downward penetration of seepage water.

On the crest of Madouban Mountain the more gentle topography, combined with the exposure of beds varying in primary permeability, has provided good conditions for karst development. On the northern flank of the mountain the steep topographic gradient causes rapid surface runoff and this has restricted karst development.

High up on Madouban Mountain rocks of the Tizkuh Formation have been thrust over those of the Lar Formation. Solution processes have been concentrated along the thrust plane.

The occurrence of dolines and caves along the crest of the Madouban anticline increases towards the west as the fold plunges towards the northwest. Permeable zones on the northern flank of the mountain tend to be oriented down the dip of the beds.

The directions of small surface streams on the mountain crest tend to be controlled by lithological and structural factors but terminate as stream sinks and become part of the underground drainage.

The direction of underground drainage is controlled by the NW-plunging fold axis and by the dip of the strata. This tends to concentrate spring activity in the western and northern foothills of the mountain.

CONCLUSIONS

The evolution of karst drainage in the area has been promoted by lithological variations, structural elements, the

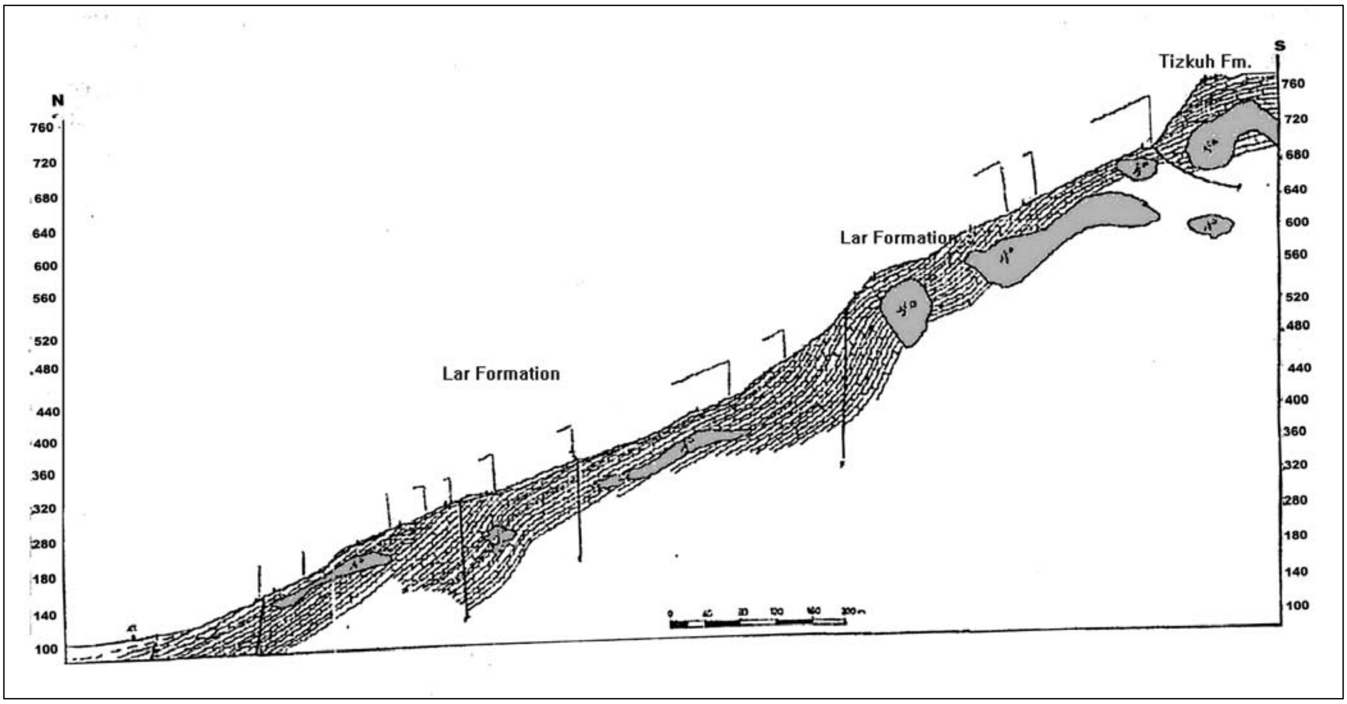

Figure 6: Structural cross-section of northern part of Madouban Mountain showing locations of geophysical traverses and permeable zones.

nature of the topography as well as climatic conditions which combine mild temperatures with humid conditions and high intensity rainfall.

The calcareous rocks of the area vary in their primary permeability. They show the combined effects of cementation, dolomitization and recrystallization followed by the development of secondary permeability due to solution processes. Solution processes have been concentrated in the thickly bedded arenaceous bioclastic limestones of the Lar Formation (Sub-units 4 and 5) and the thickly bedded *Orbitolina* limestones of the Tizkuh Formation.

Underground drainage directions have been controlled by the NW plunging fold axis and the northerly dip of the beds causing springs to be concentrated in the northern and northwestern foothills of Madouban Mountain. Surface karst development is concentrated along the crestal area of the mountain and this appears to be the principal recharge area for underground drainage.

The size and frequency of dolines is greater in the western part of the mountain crest. The Dive-Hamman collapse doline is the deepest found in the area. Other significant karst features are the extensive Zang-e-Tool and Sisara Caves. ■

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POSTER

A NEW HYDROGEOLOGICAL MAP OF THE MOLE CREEK KARST SYSTEM

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PHOTO: GARRY K SMITH

Croesus Cave. Photo Competition First Prize for Digital photograph in the Passages category.

ABSTRACT

A cave mapping and water tracing program has been used to elucidate the landforms and subsurface drainage of the Mole Creek karst system in central northern Tasmania. This work contributes to a spatial database that will assist land management planning in this intensively utilised karst area.

TASMANIAN CAVES AND KARST

– LOOKING FORWARD, LOOKING BACK

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The 49m bottom pitch in Midnight Hole.

Since the last Tasmanian ASF conference in 1993 we have greatly expanded the known boundaries of Tasmanian caves and karst in space, time and in our knowledge of how karst systems operate. Rather than focussing especially on caves, mapping of karst hydrological systems has greatly expanded the relevance of karst processes to land management in areas where few accessible caves are found.

Over 300 areas of potentially karstic carbonate rocks have now been mapped in Tasmania, some within the last ten years. Perhaps half of these contain significant cave systems. Weathering caves in sandstone and other sedimentary rocks, sea caves, seasonal snow caves and boulder caves in hillslope deposits are widespread.

Perhaps the most intriguing of these non-karst systems are found in extensive dolerite talus deposits where large closed depressions, underground stream systems, boulder caves and major springs comprise rare examples of well developed pseudokarst in non-carbonate rocks.

The diversity of Tasmanian cave biota has long been recognised, with many rare species now listed on State threatened species legislation. New species and communities are being constantly identified and described. However Tasmanian karst workers are keen for this recognition of biodiversity to be complemented by an equally strong commitment to proper management of karst geodiversity – the full range of abiotic processes and features found in karst. Reserve categories declared under the *Nature Conservation Act 2002* all contain reference to the State's commitment to the protection of geodiversity along with biodiversity. However, legislation specific to geodiversity across all tenures and similar to that used to protect rare and threatened biological communities and species, is still not currently under consideration. Formal protection of geodiversity is only possible on land reserved under the *Nature Conservation Act.* Yet, as can be plainly seen in caves and karst, many of the most fragile and non renewable elements of karst systems are abiotic and are found within a variety of land tenures.

Research is constantly expanding the boundaries of our understanding of the development of karst ecosystems. Much can be applied to landscapes surrounding karst. Recent PhDs addressing climatic and environmental history (using high resolution mass spectrometry to date and analyse environmental isotopes in speleothems) have relevance far beyond the boundaries of karst systems themselves. Subjects as wide-ranging as temperature and bushfire histories interpreted through analysis of straw stalactites, to interpretation of changing climatic patterns since the last glacial stage from flowstone cores have all been studied over recent years, using Tasmanian cave deposits. Original research into the nature of microbiotic processes in Tasmanian caves has recently been completed by local microbiologists.

Tasmanian cavers and karst scientists are beginning to work with the Aboriginal community to try and slowly unravel the cultural and environmental history of the island. The Southwest is a patchwork of landscapes whose vegetation distributions have been essentially controlled by fire. Much of the Southwest, particularly the buttongrass sedgelands and the major river valleys which formed communication routes, are largely cultural landscapes which were likely to have been maintained by Aboriginal fires. On the other hand, areas such as the New River basin, where fire has been excluded for many hundreds of years at least, form invaluable reference points for essentially natural systems. Karst systems are found throughout these areas and the knowledge contained within them will be invaluable in developing a new perspective on Tasmanian landscape history, integrating science with traditional practices.

Many Tasmanian karst areas form the basis of a complex mix of rural industries. Intensive agriculture, forestry. limestone mining, tourism and urban uses are carried out in the context of the vagaries of karst processes. Managing these highly productive lands in a way which conserves the integrity of the natural processes which underpin them will rely on developing an excellent knowledge base along with careful discussion and negotiation between all of those with an interest in using and caring for karst.

The Australian Speleological Federation will continue to play an important role in providing advice in all of these areas and in the active collection and documentation of factual information on which wise management will be based. ■

TASMANIA'S COLD CAVES:
AN ISLAND OF ALPINE KARST

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ABSTRACT

Unlike mainland Australia, much of Tasmania's karst is essentially alpine in character. During the most extensive of several glaciations an ice cap of over 7000 km^2 extended over Tasmania's Central Highlands. Glacial effects on the karst variously included the removal of surface features by glacial erosion, the clogging of pre-existing caves by glacial sediment and/or the generation of new cave passages by glacial meltwater. Away from the glaciers, other non-glacial cold climate (periglacial) effects included the destabilisation of hill-slopes when conditions were too cold to permit colonisation by the forests that now bind the slopes together; the swamping of karst surfaces by landslide and other mass movement deposits, sometimes blocking streamsinks and causing a reversion to surface drainage; interruptions to the formation of speleothems caused by changes to vegetation and/or water flow; the shattering of rock in cave entrance zones by the freezing and expansion of moisture in crevices even at very low altitudes; and an increase in the volume and size of sediment delivered into streams. Understanding Tasmania's karsts requires an appreciation of the extent to which they have been influenced by these various environmental factors. The tectonic stability of Tasmania's mountains allows the survival of very ancient alpine karst and this, together with its distinctive geographical setting, allows acquisition of evidence of global significance concerning patterns of natural climate change

INTRODUCTION

At the first ASF Conference I attended back in 1970, Albert Goede showed a stimulating map of the extent of Tasmanian karst known at that time, and it led me to devote many years to furthering the documentation of this island's karst. But after having written a few too many reviews of the extent and nature of Tasmania's karst, culminating in publication of my *Atlas of Tasmanian Karst* a decade ago (Kiernan 1995), I promised myself I would stop! So while my talk today is aimed at giving you a feel for Tasmanian karst it is not my intention to attempt any sort of comprehensive review - rather, I wish to pick up on one or two themes.

Speleos who check the net for information on Tasmania's caves soon encounter a firm warning on the web site of the local caving club that they may find caving beneath this island a little different to the conditions to which they have become accustomed elsewhere. Tasmania's caves are colder (~9°C) and wetter than those of mainland Australia, and the perils that await the unprepared range from discomfort sufficient to detract from the pleasure of a caving trip to the very real risk of potentially fatal hypothermia in the event of delay or an accident that leaves the victim immobile underground for a protracted period. I want to take this opportunity to suggest that in visiting Tasmania's caves in January 2005 you have never had it so good. Although conditions may be bracing now, they have been far more so in the past.

In virtually all karst areas, various non-karstic processes are also involved in shaping the landforms and may sometimes out-compete the dissolving of limestone, such as intense wave action in exposed coastal karsts. The thing that most distinguishes Tasmania's caves from those of mainland Australia is the importance of cold conditions, past and present. Much of Tasmania's karst is essentially alpine in character. Hence, Tasmanian caves are in stark contrast to those of mainland Australia where, if conventional geographical or ecological definitions are adopted, no true alpine karst exists (although

PHOTO: ALAN WARILD

"Next time, could you please hold the Conference in summer?" Michael Wasmund came prepared.

the rules of definition are occasionally bent for various reasons) (Spate and Houshold 1989).

While caves have fascinated me since I was a kid, my scientific interests were kindled more by time spent at the original Lake Pedder, a remarkable glacial landform. So despite studying caves and karst over a period of 35 years, I have probably now spent more of my time on, under and around glaciers than I have around limestone - and after five decades I still can't decide what I want to be when I grow up: caver or alpinist? glacial or karst geomorphologist? So in this talk I want to bring these two perspectives together and consider the implications of alpine conditions for the evolution of Tasmanian caves and karst.

Alpine karst is special, and not just for its often scenically spectacular setting or even the fact that it is in such areas that the deepest cave systems are able to develop. In alpine karsts the water necessary for cave formation may at times be frozen into immobility, and there may be limited vegetation to produce the organic acids that aid rock dissolution. But abundant seasonal meltwater released from snowfields and sometimes glaciers can foster rapid landform evolution. Steep hydraulic gradients foster deep phreatic looping, incised canyons and vertical shafts that require technical caving techniques. Valleys may be deepened by glacial erosion that permits energetic water circulation through evolving caves, or they may be filled with sediment causing back-flooding in karst systems and the development of new cave passages (Ford 1983, Smart 2004). Understanding our alpine karsts requires understanding the extent to which such processes have previously operated – and, because caves are often important storehouses of information about past environmental conditions, this may have much to tell us about climatic history (Goede and Harmon 1983).

Webb et al. (1992) failed to find evidence of climatically-driven influences on landscape evolution at Buchan in Victoria, and have argued that the glacial and periglacial episodes that had such a great influence on karst landscapes in the northern Hemisphere occurred in only small areas of Australia's southeastern highlands and Tasmania. However, this perhaps overlooks the magnitude of such cold climate effects on karst in Tasmania where an ice cap of over 7000 km^2 once existed in the Central Highlands, extensive glaciers also developed elsewhere, and other cold climate influences are evident down to present sea level (Kiernan 1990a).

GEOGRAPHY AND EARLY HISTORY OF TASMANIAN KARST

The geographical context of Tasmania's caves

Why should Tasmania's caves be as cold as they are? After all, at latitude 43° S Tasmania is no closer to the pole than sunny Spain or the paradise of millionaires on the French Cote d'Azur. So why are we not drifting from sun-drenched entrance to sun-drenched entrance, pausing only to pluck a few more olives or down another bottle of red? The answer lies in the marked asymmetry of climate between the northern and southern hemispheres. Heard Island, home of Australia's most remote lava caves, endures a climate that makes Iceland look tropical, yet it is located at about the same latitude as London (53°). Forests are common north of the Arctic Circle, but there are no trees south of the Antarctic Circle. People live and work at 66° N in Alaska, yet at equivalent southern latitudes we have the ice-bound coast of East Antarctica. While one can paddle happily in the ocean when the summer sun shines at 70°N on the northern coast of Alaska, at the equivalent latitude in the southern hemisphere one is well on one's way inland up the world's largest glacier, the Lambert Glacier in the Australian Antarctic Territory, which drains from the highest point of the Antarctic polar plateau.

Why should this be? Due to both the curvature of the Earth's surface and the tilt of the axis about which it rotates solar energy is received unevenly across the surface of the Earth. Atmospheric circulation resolves part of this imbalance by redistributing energy. Circulation of the oceans that cover two thirds or our planet also plays an important role but in the southern hemisphere elongate land masses form barriers to oceanic circulation. And in contrast to the northern hemisphere which is dominated by continental land masses, at southern temperate latitudes there is mostly water, and Tasmania forms an island with many thousands of kilometres of unbroken ocean stretching westwards to the Patagonian coast on the other side of the globe - little wonder that a certain amount of moisture rides the westerly Roaring Forties airstream that softly caresses our island.

Climate and the origins of Tasmanian limestones.

It has not always been as cold as it is now, partly because the Earth's land masses have not always been located in their present positions. Tasmania's limestones were deposited under both warmer and cooler conditions than exist at present - two examples of this variation should suffice.

As part of the super-continent of Gondwana drifting around on an evolving globe, the Tasmanian region lay in warmer latitudes during Ordovician times 500-434 Ma BP (million years before present), and it was there that the coral reefs that formed our principal karst-hosting rock, the Gordon Limestone, were originally laid down in a tropical environment (Rao 1989). But evidence of a later dramatic shift in Tasmania's climatic fortunes is spectacularly displayed at the entrance to Three Falls Cave in the Florentine Valley, where the steeply-dipping tropical limestone that was deposited in an environment somewhat akin to the present Persian Gulf, is overlain by near-horizontal sedimentary rocks of Permian age (~300-250 Ma BP) that instead bear comparison with those that are currently forming beneath the Ross Ice Shelf in Antarctica.

By the Permian period the Tasmanian region had drifted into polar latitudes. Present day Antarctica was still attached to Tasmania and was moored somewhere off Queenstown, such that glaciers swept across what is now Tasmania. A glacially-abraded rock pavement from this period has since been exhumed from beneath the Permian rocks at Mt Sedgewick, just upstream from the Dante karst in Tasmania's West Coast Range. Glacial sediments were deposited directly by these Permian glaciers, mostly in the western half of Tasmania, while further east melting ice-bergs rained down rocks eroded from Antarctica and western Tasmania onto the beasties living on the sea floor - fossils pulverised in this way may be seen among those in the Permian rocks at Three Falls Cave. The limestone that forms the Fossil Cliffs at Maria Island off Tasmania's east coast were deposited in these cold polar seas, and if you visit there you may see that some of the large scallop-like *Eurydesma* shells at this site have similarly been blitzed by ice-berg bombers. In contrast to the Ordovician limestones, there are few caves in these relatively impure Permian limestones, the largest being near Gray in NE Tasmania and the sea cave Tear Flesh Chasm near the Fossil Cliffs.

When did caves start to form?

Once limestone is exposed in a terrestrial setting, karst commences to develop. The best-documented of Tasmania's palaeokarst occurs at Eugenana in northern Tasmania where limestone quarrying many years ago revealed ancient caves filled with sediments. Examination of spores in the cave sediments revealed species that were last around during the middle Devonian (~380 Ma BP), implying that the caves had been present for at least that long. The cave sediments also told a further important story: while the limestone is intensely folded, the cave sediments remained horizontally-bedded, implying an episode of mountain building prior to the caves being formed. Hence, these caves provided evidence for the age of one of the most important phases of mountain building in Tasmania's geological history (Banks and Burns 1962). Parts of some cave systems may be even older, and caves have probably also been forming ever since – although the present form of the best known Tasmanian caves is very much younger. Such antiquity of some karst elements is not particularly unusual - cave development at Wombeyan, NSW, also began in the Devonian (Osborne 1993).

The landscapes in which these events unfolded were vastly different to those that exist today – indeed some of the most important rocks that dominate Tasmania's topography today were yet to be formed. After the Permian glaciers vanished from Gondwana great thicknesses of river and lake sediments accumulated. Subsequently, in Jurassic times (~204-131 Ma BP) a vast amount of molten magma was intruded in between the horizontal bedding of these sedimentary strata, where it spread out between them like the ham in a rock sandwich. This magma cooled to form the dolerite that is now widespread. Over subsequent aeons the upper slice of "bread" was eroded away, leaving the harder dolerite "ham" capping the mountains - herein lies the explanation for the dolerite cap and tabular form of many mountains in eastern Tasmania.

These rock sequences were subsequently riven by fractures and faults generated by earthquakes that raised or lowered various blocks relative to others. Combined with progressive incision by eroding rivers, this left the underlying limestones exposed along the sides of valleys and hills where acidic runoff from the dolerite summits began to form karst where limestone was exposed, at places like Mole Creek, Junee-Florentine and Ida Bay. Minor remnant evidence of very early karstification is to be seen in some of these places - just as many karsts in mainland eastern Australia have also experienced a phase of karstification in the Tertiary prior to their burial under gravels or basalt (Osborne & Branagan 1988).

Climate and karst in the more recent past.

We now come to the cold origins of Tasmania's present caves. At the commencement of the Tertiary (~65 Ma BP) Australia, Antarctica and South America were still joined and the first two were covered in rainforest – despite the fact that Tasmania lay 2500 km south of its present position. But after ~45 Ma BP the northward drift of Australia broke the connection between Tasmania and Antarctica, hence oceanic circulation was altered. The new Antarctic Circumpolar Current began to form a barrier that prevented warm water from lower latitudes reaching the Antarctic coast, conditions cooled and glaciation was initiated virtually simultaneously in Antarctica and Tasmania prior to 30 Ma BP in Oligocene times. The only place on Earth outside Antarctica where this onset of glaciation in southern polar regions is recorded is just upstream from the Lorinna karst in northern Tasmania (Macphail et al. 1993). Significantly, the glacial sediments at this site lie close to the bottom of the Forth River Valley, implying that this valley already existed and that recognisable elements of the landscape in which our present crop of karst and caves were to evolve were now becoming recognisable. By analogy with the Forth Valley, it seems probable that some of Tasmania's other major valleys were also in existence by this time and that the limestone in some of these areas had already been exposed to karstification.

A sequence of sediments that overlie limestone in the Linda Valley in western Tasmania highlights the magnitude of environmental change implied by such rapid cooling (though not necessarily the same event) and its implications for karst development. At Linda alluvial silts were deposited by a stream that carried fine sediment particles that had been produced primarily by chemical weathering that occurred when the vegetation cover maintained slope stability and generated organic acids that decomposed the rocks, a situation highly conducive to karst formation. The silts contain pollen of rainforest species now found only in New Guinea and New Caledonia but also once present in Antarctica, and a fossil soil that formed on the silts contains fragments of wood related to the present-day Tasmanian celery top pine. But the stability implied by this soil terminated when a great influx of gravels was dumped by a stream that carried chunks of rock that had been prised from surrounding slopes by strong physical weathering in a cooler environment where little vegetation remained. The entire sequence was then over-run by a large glacier at a time when an ice cap of over 7000 km^2 covered Tasmania's Central Highlands. Limestone at Linda was buried beneath a vast thickness of glacial sediments, as was other karstified limestone in the Queen and King valleys, and elsewhere (Kiernan 1990a, 1995). Tasmanian karst had now assumed an alpine aspect.

COLD-CLIMATE PROCESSES IN TASMANIA'S ALPINE KARSTS

Over the last 3-4 Ma global climate has repeatedly cooled during what are termed Glacial Climatic Stages and then re-warmed during Interglacial Climatic Stages such as we have been experiencing for the last 10 ka (10 000 years). The implications of these episodes of cold climate for Tasmania's evolving caves have been profound. There are three principal types of specifically cold-climate processes that operate in alpine karsts - glacial and glacio-fluvial processes, p*ara*glacial processes and p*eri*glacial processes. Each has been important in Tasmania. A brief explanation of these terms is warranted before we continue.

Glacial (including glaciofluvial) processes

Glacial processes are those that are the direct consequence of glaciers eroding away rock or depositing sediment. *Glaciofluvial* processes involve erosion or deposition by the liquid melt-water that is generated on, within and at the margins of glaciers. A variety of different impacts of these processes are evident in Tasmanian karsts.

All glaciers are made of ice, but not all ice is the same. In continental interiors conditions may be so cold that ice sheets remain frozen to the ground and the flow of ice downslope is permitted only by internal deformation and slippage between ice crystals. Under such circumstances, glaciers are unlikely to erode away much pre-existing karst or to pick up much sediment that can later be deposited elsewhere. Conversely, in more temperate mountain settings closer to the sea as in western Tasmania the ice is commonly a little warmer so that meltwater is able to exist within and at the base of the glaciers, enabling the ice to slide on a film of water, ripping out pieces of the underlying rock which are then frozen into the glacier base thus converting slippery ice into highly abrasive sandpaper. Glaciers of this kind erode more efficiently than continental glaciers, thus picking up more rock fragments and hence depositing more sediment downstream, either as *moraines* (well-defined ridges) or just sheets of *till* (glacial sediment). They also generate considerable volumes of meltwater which carry silt and gravel which are ultimately deposited as *outwash sediments.* Depending on particular circumstances meltwater streams may block caves with sediment, or, alternatively, carrying just enough sediment to equip the water with highly abrasive tools that allow the streams to rapidly enlarge developing caves and hugely expedite cave evolution. Between these two extremes - stifling or enhancing cave formation - are many shades of grey (Ford 1983, Ford and Williams 1989).

The meltwater drainage systems within a temperate glacier are themselves highly karst-like. Water flows across the ice surface to streamsinks that typically form at the intersection of joint systems (such as incipient crevasses) and flow through tunnels within and beneath the ice mass that are enlarged by flowing water and particularly by air currents (Kiernan 1993). Most of Tasmania's major rivers once originated from such melt-karst systems, such as the 70 km-long Derwent Glacier (Kiernan 1985, 1990a). These were probably the biggest cave systems ever present in Australia, but the organisers of this conference have thoughtlessly scheduled it thousands of years too late for you to take a look-see. Sometimes meltwater streams carve channels into the bedrock beneath the ice, as in Tasmania's King Valley (Kiernan 1981). The 30 m-deep limestone gorge through which the Dante Rivulet flows was probably formed partly as such a basal meltwater channel. Where the underlying rock is limestone, the pseudokarst hydrology in the glacier is superimposed on the true karst hydrology. The additional hydraulic head in the glacier can pump water more energetically through the karst beneath the ice than would otherwise be the case (Kiernan 1993). The best-documented cave of this kind is Castleguard Cave in the Canadian Rockies, which penetrates beneath the Columbia Icefield with passages ascending to the base of the glacier - the entire cave has at times been entirely over-ridden by ice, and it contains a stygobitic fauna that appears to have survived at least one such ice age in the sanctuary of the cave (Ford 1983).

No previously-glaciated karst occurs on mainland Australia but at least 53 separate Tasmanian karst areas are known to have been glaciated (Kiernan 1995). In some cases relatively recent glaciers have left fresh moraines, as at Lake Sydney and Dante Rivulet. Aerial photographs suggest various other likely glaciated karsts in areas that have never been visited by cavers, such as the Erebus-Denison area where large depressions occur at ~850-950 m altitude (Kiernan 1995). Care is required because closed depressions don't have to be karstic - they can also be caused by glacial processes, such as the melting of blocks of ice within glacial sediments.

However, it would be very wrong to assume that the karst now present in an area that has previously been glaciated is necessarily somehow the product of past glaciation. In many cases present-day karst features in some glaciated areas have probably developed since the glaciers vanished and have no direct relationship to patterns of glacial erosion or of meltwater flow. For example, the Vale of Belvoir karst is heavily mantled by glacial sediments that are pock-marked by sinkholes, many of which are water-filled. Whether the sinkholes have formed since the glaciers vanished or represent flushing of old pre-glacial karst since the ice retreated is an open question but palaeomagnetic dates suggest a pre-Pliocene age for the till (Augustinus and Idnurm 1993), suggesting ample time has elapsed for karst features to have formed since deglaciation. The sinkholes at Carbonate Creek in the upper Franklin River catchment and in various other areas are probably also entirely postglacial, with any glacial influence restricted to that caused by the thickness of the surface sediments and its impact on postglacial karst processes.

Paraglacial processes

It is now time to introduce a potentially confusing but important term. *Para*glacial processes involve various non-glacial processes that have been conditioned by prior glaciation (Ryder 1971, Church and Ryder 1972). They include the adjustment of slopes left in an unstable condition as the climate warmed and glaciers retreated. Hence, steep rock walls tend to relax, crack open and sometimes collapse once the glacier that eroded them vanishes and ceases to support them (Blair 1994). Joints produced by this unloading of valley sides can also provide a focus for water to penetrate and initiate caves, but the same process can result in caves inside the valley wall being destroyed by large-scale collapse, as appears to have occurred in the Timk Valley at Mt Anne. Similarly, moraines that were originally deposited against glacier margins and left unsupported when the ice withdraws often collapse and are washed away to form new alluvial deposits - but which bear an imprint of past glaciation. Much of this change occurs fairly soon after the ice or glacier retreats but before conditions have re-warmed sufficiently for forest to re-establish and help stabilise slopes.

Recognition of material originally emplaced by glaciers can become complicated when the material is redistributed by paraglacial landslides or when stream action reworks it into alluvial fans. The problems increase when the glacial sediments are ancient because a variety of additional processes are likely to have also intervened and given the material many characteristics of non-glacial processes. Hence, while it has been argued that a glacier once flowed down the Leven Valley to near the present coast (Colhoun 1976), large alluvial fans formed by streams re-working old glacial sediments are more prominent at ~60-100 m altitude at the Gunns Plains karst ~18 km upstream than are moraines - material more clearly of glacial origin remains intact at ~450 m altitude ~27 km further upstream at the Loongana karst, but fresh moraines are found only above 900 m altitude in the uppermost headwaters on Black Bluff. Context is all important when seeking to interpret old deposits.

Periglacial processes

Another group of cold-climate processes have nothing to do with glaciers but have confusingly been termed periglacial processes (note: *peri* not *para*) because they were first described from cold environments near the margins of glaciers. Periglacial processes can occur only on unglaciated surfaces. They persist today in high mountains and glacier-free polar areas, but they influenced a much greater proportion of the globe during the Glacial Climatic Stages when climatic conditions reduced the vegetation biomass allowing wind, water and ice much greater access to the ground.

Periglacial processes include the physical breakdown of rocks by processes such as frost shattering whereby moisture that penetrates into fractures expands upon freezing. Even close to sea level on the lower Franklin River, angular rubble was frost-wedged from the roof of caves such as Kutikina and Deena Reena, both before and during the time Aborigines sought shelter there during the most recent phase of intense cold ~15-20 ka BP (Kiernan et al. 1983). The resulting shattered rubble is moved down hill-slopes by a variety of processes, which leads to streams carrying coarse cobbles away from the mountains rather than the fine sands, silts and clays mostly carried today when vegetation covers the slopes and contributes to organic acids that chemically decompose rocks. During colder times the forest biomass in Tasmania was much less than now, slopes were exposed to intense physical weathering and were prone to various forms of slope instability which as Goede (1973) has demonstrated in the Junee area were sometimes sufficient to block streamsinks and caves and force a reversion to surface drainage.

Freezing of the ground, either long-term (permafrost) or diurnally, is another typical periglacial process. There are obvious implications for cave and karst development if the supply of liquid water needed to dissolve limestone is shut down by freezing. This phenomenon, coupled with vegetation changes, may underlie the observation that speleothem growth tends to slow or halt in temperate alpine regions during Glacial Climatic stages, as Goede and Harmon (1983) have demonstrated in Tasmania. Seasonal or diurnal thawing of ice in the ground may saturate the soil and allow it to flow downslope, a process that is particularly effective if there is permafrost at depth because the melted liquid cannot penetrate the permafrost and becomes perched on its surface, elevating pore water pressures beneath the thawed ground. There is evidence for only limited permafrost in Tasmania, but seasonal freezing and resultant slope instability was widespread. Cave development may be particularly focused downstream from large snowdrifts that release meltwater (Ford and Williams 1989).

Periglacial processes likely effected only a small handful of karsts in the highlands of southeastern Australia such as Wombeyan, Yarrangobilly and Cooleman Plain (Jennings 1967, 1985; Gillieson et al. 1985), but periglacial phenomena have now been recorded from 198 Tasmanian karsts.

Other cold-climate impacts beyond the mountains

Sediment swept down-valley from the highlands by seasonal meltwater streams inundated the evolving karst in some lowland valleys. By this means the effects of cold climate were felt in many karsts even well-removed from the mountains. Given evidence of periglacial processes once occurring down to present sea level in Tasmania (Colhoun 1977a,b) it is likely that few if any karsts escaped significant periglacial impacts - hence even some of our coastal karsts have an alpine aspect. As in all other parts of the world, karsts close to the coast were also influenced by a fall of global sea levels by up to 150 m that resulted from water being locked up in global ice-sheets and glaciers. This had the effect of steepening the hydraulic gradient through coastal karsts until sea level rose again as the climate warmed and the great ice sheets melted.

QUINTESSENTIALLY ALPINE: REVIEW AND SPECULATION ON SOME TASMANIAN GLACIATED KARSTS

Glacial erosion versus karst dissolution

One of the more conspicuously glaciated Tasmanian karsts is at Mt Anne, where a major valley glacier previously flowed 9 km down the Timk Valley, a cirque was eroded into the end of the karstic north-east ridge, and smaller glaciers formed on surrounding hills (Kiernan 1990b,c, Kiernan et al. 2004). Lake Timk lies in a large basin that is drained underground to a spring in the neighbouring Snake Valley >2 km distant - there is surface overflow from Lake Timk only on very rare occasions. As is quite common in alpine karsts, a chicken-and-egg question arises in relation to the origin of the depression.

Is it simply a typical glacially-eroded depression (cirque) from which karstic channels have since evolved? Or was it originally a sinkhole that focused glacial erosion giving rise to the present glacial lake basin? A similar chicken-and-egg issue arises in relation to some of the glacial lake basins in the Frenchmans Cap massif, some of which lie in areas where there is dolomite (Peterson 1960) that is known to contain some small caves. Might preglacial sinkholes have provided the foundation for the spectacular glacial lakes that now characterise this landscape? Combined sinkholes and cirques are also present in the Picton Range where the same question arises (Kiernan 1989a).

Karst formation beyond glacier snouts

Small moraines occur at the head of the valleys that drain into both Khazad-Dum and Growling Swallet, implying that small glaciers were once present in these locations and proglacial meltwater from their snouts previously flowed towards the caves. Jennings and Sweeting (1959) suggested that the underground course of Mole Creek was influenced by proglacial meltwater being forced to flow around the edge of large outwash gravel fans and against the bordering hill margins in which caves were developed. Proglacial meltwater has discharged onto limestone in many other areas including parts of the Precipitous Bluff karst and in the Vale of Rasselas.

Karst formation beside glaciers

Meltwater discharged from and along the sides of glaciers seems implicated in the formation of caves in several areas. The caves at Mt Ronald Cross are located broadly coincident with the margin of the former Surprise Glacier, suggesting meltwater from the ice margin may have played a role in cave location, its action perhaps focused on valley-wall unloading joints. In some cases meltwater formed caves some distance from the lateral ice edge. Meltwater discharged from the edge of a glacier that descended the Lawrence Valley from the Mt Field massif towards the floor of the Florentine Valley scoured an impressive channel through a lateral moraine of glacier-edge debris and spilled downslope to Welcome Stranger Cave, in which gravels have been deposited on at least two occasions (Kiernan et al. 2001) - the possibility exists that the cave was originally formed in this way. Moraines constructed along the sides of glaciers can also block the descent of streams from adjacent mountain slopes. A massive sinkhole on the western side of Mt Gell may be of this origin, having formed where meltwater or tributary streams were trapped behind a moraine barrier on the edge of the former Alma Glacier.

Karst formation beneath glaciers

Karst features in the uppermost Dante Valley in the West Coast Range have also been over-ridden by glaciers during even the most recent and restricted glaciation known to have occurred in Tasmania. The deep and narrow limestone gorge with occasional underground segments that has been incised down the axis of the valley probably owes its origin, at least in part, to meltwater flowing at the base of the Dante Glacier – this gorge is certainly too deep to have formed over the few thousand years since the glacier last retreated (Kiernan 1995).

Lake Sydney at Mt Bobs occupies a substantial cirque at the downstream end of which sinkholes have formed. These sediment-choked sinkholes are incapable of evacuating all the winter rains and snow-melt and hence become flooded to form an extension of the lake. The valley floor between Lake Sydney and Pine Lake is similarly mantled by glacial sediments, but tributary streams that descend from the valley walls are slowly re-excavating their way back down through glacial sediments into the pre-existing karst system (Kiernan 1989a).

Although the most recent glaciers vanished 10-16 ka BP flushing of the system has still not been achieved. This site lies at the very head of the valley hence it is likely that the system is over-ridden during each glaciation, however minor. It may be that cave development is most effective when the advancing glacier bulldozes away the sediment deposited during its previous retreat because then meltwater under the additional hydraulic head within the glacier is able to vigorously scour and enlarge the cave system. If so, this karst system may constitute a subglacial, subterranean meltwater channel - but it may be preglacial.

Multiple glaciation of Tasmanian karsts

In some cases karsts occur sufficiently far upstream in valleys that have been repeatedly glaciated that they must have been over-run during numerous glaciations. For example, the Sophia River karst was repeatedly over-run by glaciers but these caves are now lost to us beneath the Pieman River hydro-electric reservoir so we may never get to know their secrets. Similarly, the karst around Mt Cripps and in the lower Fury Valley/Mackintosh River area has been repeatedly glaciated.

In an early glaciation a glacier flowed down the Lawrence Creek Valley onto the floor of the Florentine Valley, depositing a thick carpet of glacial sediment. It seems reasonable to assume that the limestone in the Florentine Valley had been exposed long enough for karst to have evolved prior to the earliest of the glaciations. It is conceivable that the largely sediment-choked system we see today was formed during one or more interglacials – although if the present condition of the system is anything to go by interglacials may have allowed only partial flushing of sediment from the ancient system rather than an opportunity to elaborate the caves by active erosion of the limestone bedrock. More effective flushing and cave enlargement may have been achieved during glacial advances when ice did not reach the floor of the Florentine Valley but was restricted to the upper reaches of the Lawrence Valley from which torrents of seasonal meltwater were released. A similar history of caves being plugged by sediment when over-ridden by glaciers and then flushed out at other times is evident from Nelson River where the limestone is mantled by glacial sediment and remnants of glacial outwash gravels remain lodged in some passages and niches (Kiernan 1983).

Ancient glaciers and celebrated Tasmanian karsts

There are various other Tasmanian karsts that have been over-ridden by glaciers only during the earliest and most extensive glaciations. They include the karst at Forest Hills below Federation Peak, karst areas in the middle Picton, middle Huon and lower Weld valleys, at Loongana in the Leven Valley and Lorinna in the Forth Valley. But still further from the source areas where the glaciers arose are some karsts where the presence of more ancient glaciers is possible but has proven harder to confirm. But determining just how extensive the glaciers were during the most intense glaciations is important if the total extent of past interactions between glacial and karst processes is to be understood.

Confirming the former presence of ancient glaciers can be difficult because glacial sediments tend to be reworked over time into other deposits such as river gravels, or are buried by younger non-glacial deposits. The situation is further complicated by the fact that some forms of glacial sediment can appear similar in character to material deposited by some other processes such as landslides and solifluction. This has led to over-estimation of glacier extents in the past and means that the possibility of glaciation in some additional areas (eg. Moina, Hastings) is yet to be substantiated. The converse situation can also apply with former glacier limits being underestimated. For example, glacial outwash exhibits structures indicative of deposition by running water that can lead to its misinterpretation as a conventional fluvial deposit. Extensive experience in glacial environments and knowledge of the wider context of the deposits is critical to reliable interpretation.

We know that the earliest glaciations were much more extensive than those that occurred more recently, but they occurred so long ago that the distinctively glacial landforms and sediments they produced have since been reworked into other types of sediment making any glacial origins difficult to discern.

Under such circumstances the presence of glacial *erratics* (rock types that do not outcrop in an area and can only have been carried there by a glacier) offers one clue, as can our knowledge of the relative magnitude of different glaciations. If the glacial deposits close to the karst area are young then it is possible that the more extensive earlier glaciers reached it.

One means by which the relative age of glaciations has been determined has been by comparison of the extent to which glacial deposits have been weathered since their deposition. Insufficient time has elapsed for the most recent deposits to be more than minimally degraded while the oldest deposits have been significantly eroded and decomposed. Where the evidence is best preserved there are commonly fresh, intact moraines at the upper end of a valley, then older, more degraded moraines further down-valley, and finally deeply-decomposed ancient glacial deposits many kilometres further downstream. Hence, we cannot assume that the furthest down-valley recognisable moraine in any area necessarily marks the absolute limit of past glaciation - although neither should we assume that it cannot!

Junee area

As Goede (1973) correctly deduced long ago, dolerite-rich slope deposits produced by periglacial and other slope processes outside glacier limits during cold climate stages filled many pre-existing karst depressions, blocked streamsinks and forced local reversion to surface drainage in the Junee area. Where did all this dolerite originate? The dolerite summits between Tyenna Peak and Wherrets Lookout provide an ample source for the western part of the Junee area, but further east a direct glacial influence has now been recognised (Kiernan et al. 2001).

Although dolerite rubbles many metres thick overlie the limestone in the Khazad-Dum/Threefortyone Cave area, the only upslope bedrock source for all this material is a dolerite outcrop of ~0.2 km^2 at the summit of Tyenna Peak, hardly sufficient to spawn the massive accumulations downslope. Glacial features in the adjacent Humboldt Valley including moraines that extend southwards from the upper Humboldt and into the Junee area clearly demonstrate that the Humboldt Glacier overflowed onto the eastern part of the Junee karst, dumping huge amounts of glacial sediment and deflecting meltwater flows towards those places where the principal caves now occur (Kiernan et al. 2001). But that occurred long ago, and this glacial sediment has since been reworked into solifluctates, landslide deposits and alluvial fans. Given the implied extent of past glaciers, ice and meltwater may also have spilled from the plateau and influenced cave development further west.

Florentine Valley

We touched earlier upon the impact of the former Lawrence Glacier which descended from the K-Col area behind Mt Field West onto the floor of the Florentine Valley. What other parts of the Florentine Valley might have been affected by glaciers? In the Lawrence Valley, small and fresh moraines occur for 2.8 km below K-Col while the glacial landforms 3 km further downstream are more degraded and the glacial sediment on the floor of the Florentine Valley >8 km from the valley head is so heavily reworked and deeply decomposed that we may never know just how far the glacier extended westwards when the ice was most extensive. Significantly, ice from the same source near K-Col also descended into the Garth Creek Valley which contains Growling Swallet. This implies that at the very least glacial meltwater has played a role in formation of this celebrated cave, but just how far did the Garth Glacier extend at maximum phase? As in the upper Lawrence Valley, small fresh moraines occur at the head of the Garth Valley. No older glacial deposits have been confirmed further downstream towards Growling Swallet but given the common ice source area it seems probable that earlier glacial advances in the Garth Valley would have been as proportionately larger as they were in the Lawrence Valley. Hence, it is likely that much of the dolerite-rich sediment that has buried the limestone in the lower Garth Valley was originally glacial sediment, the character of which has been greatly changed by subsequent erosion and re-deposition by non-glacial processes such as periglacial solifluction. This would imply that Growling Swallet was actually over-ridden by glaciers and that various neighbouring caves have also been points of meltwater input (Kiernan et al. 2001). Identifying the precise margin between the solifluncted glacial sediments and the non-glacial solifluncted slope deposits on the western slopes of Mt Field West may prove impossible, but concerted research in the caves may prove very profitable.

Elsewhere in the Florentine Valley small glaciers also formed on Wylds Craig during the most recent glaciation, and during the earlier, more extensive glaciations ice conceivably reached the limestone floor of the Florentine Valley in the Cole Creek area. And in the very headwaters of the Florentine River moraines extend downslope from a small cirque on The Thumbs, with outwash sediments spread across the limestone valley floor.

Ida Bay

Goede (1969) pointed out that the position and form of the D'Entrecasteaux anabranch passage of Exit Cave are consistent with its having been formed by glacial meltwater being decanted off the margin of an outwash fan and against the foot of the Marble Hill. A major moraine deposited by a glacier at least 4 km long extends down the slopes of the Southern Ranges onto the floor of the D'Entrecasteaux Valley at ~240 m altitude to within 4 km of Exit Cave. The glacial sediments are only moderately weathered, implying the likelihood that the earliest glaciers extended much further. The configuration of the Hammer Passage and the nature of the sediments it contains are somewhat similar to the D'Entrecasteaux anabranch and it is conceivable that meltwater discharged directly from an earlier, more extensive glacier may have been involved, possibly including development of a recharge point at the western end of the Grand Fissure (Kiernan 1991). But much more research on the surface sediments is required to explore this intriguing possibility.

Gunns Plains

That Gunns Plains was over-run by the former Leven Glacier is implied by the suggestion of Colhoun (1976) that a glacier once reached the Alison Golf Links ~18 km further downstream. Unequivocal evidence for glaciers having extended this far is yet to be found but several lines of evidence suggest it at least reached Gunns Plains. This evidence includes poorly-sorted deposits containing boulders of erratic rock types that do not appear to belong in the valley, some of which are so large (up to several metres diameter) that they could not have been transported by the Leven River. As at Junee the present character of the sediments is generally not glacial - most now occur in alluvial fans, suggesting *para*glacial redistribution of the original glacial sediment and/or reworking by *peri*glacial and other processes. In this case, no obvious relationship between the present caves and possible former glacier hydrology or ice margins has yet been discerned – the caves may have simply evolved since these very ancient glaciers were present.

Mole Creek

Joe Jennings first suggested back in the 1960s that glacial meltwater from the Great Western Tiers had influenced development of caves at Mole Creek (Jennings and Sweeting 1959, Jennings 1967). But was the influence of past glaciation confined solely to meltwater action kilometres downstream from any actual glacier as Jennings hypothesised?

Progress on elucidating the patterns of underground drainage at Mole Creek has been slow. Nearly two decades elapsed between the work by Jennings and my own studies (Kiernan 1984, 1989b, 1992). Then close to another two decades elapsed before any further substantial research on the karst hydrology was initiated, this time by the Tasmanian Department of Primary Industries, Water and Environment (DPIWE).

While I would anticipate that after 20 years there are bound to be some major advances on the results of my old reconnaissance-level work, I am not privy to the results of the DPIWE work, so will hazard a few comments on cold climate influences based on the earlier work.

Glacial outwash is abundant in the Union Bridge area but it does not require a glacier having reached as far as Mole Creek, only that a glacier once lay further upstream. But Eric Colhoun and Albert Goede both found deposits at two separate sites on Mersey Hill that they considered probably glacial (Colhoun 1976), and my own studies some years later suggested extensive glaciation (Kiernan 1982, 1984, 1989b). Hannan (1989) subsequently confirmed glaciation of the Croesus Cave area in his Masters thesis on glaciation of the Mersey Valley. The most recent work has revealed unequivocal glacial deposits beneath the outwash near Union Bridge. This material, known as basal till, comprises tough, preconsolidated sediment that is plastered onto the ground beneath the pressure of a glacier, and studies of its fabric (the packing and orientation of its grains) has confirmed its glacial origin.

How thick was this ice? Reworked sediments of probable glacial origin that occur on Mersey Hill would imply at least 60 m of ice over the site of the present Mole Creek township. What were its implications for the karst? While Jennings and Sweeting (1959) argued that the position of some cave passages just inside the margin of hills located beside fans of glacial outwash gravel was due to meltwater being decanted from the fans onto the hill margins, an alternative explanation now is that meltwater from the glacier base was involved - but for now this remains speculative because much more work needs to be done to explore this fascinating possibility.

It is even possible that the entire Mole Creek area was totally buried beneath a massive thickness of ice. Sediments that contain material that may originally have been glacial occur far downstream to beyond the Railton karst, 15 km north of Mole Creek. If these sediments are truly paraglacial it would imply Mole Creek having been very deeply buried by ice with Mt Roland standing as a nunatak above the glaciers – but paraglacial reworking of the sediments and serious errors in published geological maps do not help to resolve matters (Kiernan 1982).

CONCLUSIONS: THE SIGNIFICANCE OF TASMANIA'S ALPINE KARST

Many Tasmanian karsts are essentially alpine in character. Cold-climate processes have influenced the character of most Tasmanian karst areas, a substantial number of which have been glaciated. Some of Tasmania's most celebrated caves are among those influenced by past glaciers. These alpine karsts are of great scientific interest.

From a scientific standpoint, the greatest importance of Tasmania's alpine karst lies in its tectonic setting, its antiquity and its geographical location. While alpine karst is relatively common worldwide, it typically occurs in areas of active mountain-building where a rapid pace of development and destruction limits the potential for survival of ancient alpine karst. For example, in New Zealand's Southern Alps there has been over 18 000 m of uplift during the last 3 million years, sufficient to raise Mt Cook to twice the height of Everest had not erosion outpaced the uplift. In contrast, the relative stability of Tasmania's mountains allows the survival of very ancient alpine karst. This highlights the capacity of Tasmanian caves to provide evidence of global significance concerning patterns of natural climate change over a very long time scale.

Palaeokarst phenomena are to be anticipated virtually anywhere pure limestones have been exposed to karstic processes prior to the present erosion cycle, but the topographic context has often been quite different to the present. Hence, in the best known alpine karst in Europe, Vercors, karstic pockets filled with weathered soils are associated with Eocene fold structures, but the relief remained moderate during the Miocene and remnant karst features are now disconnected, truncated or unroofed. Precursors of the deep cave systems such as Gouffre Berger did not appear until after 5-6 Ma BP with development of the largest and highest levels of major cave systems developed only in the last 1.5 Ma (Audra 2004). But the Forth Valley near the Lorinna karst was already exposed when glaciation first gripped the Antarctic region 30 Ma BP - this is the only place in the world outside Antarctic where this onset of Antarctic glaciation is recorded. By analogy with the Forth Valley, its seems likely that many other Tasmanian valleys in which karst is exposed have also existed in their present form for a very long time. In this sense, the great antiquity of the Australian continent is replicated in Tasmania's alpine karsts, but at the same time the vigorous alpine processes that have shaped some of the world's most celebrated karsts in more recent and rapid time are also present here.

We must also consider the important geographical location of Tasmania. The climatic asymmetry of the Earth means that the climatic histories that have been compiled from northern hemisphere evidence are not necessarily applicable to the southern hemisphere. Because southern temperate latitudes are mostly oceanic there are few locations where terrestrial evidence of climate change can be obtained. The paucity of karst in the Patagonian Andes and the rapid tectonic uplift of both that area and New Zealand's Southern Alps limits the length of the record that is ever likely to be obtained.

Uplift compounds the difficulties entailed in inferring past climate because glacier extent during different glaciations may owe more to the height of mountains at the time than to the magnitude of truly regional climate severity at southern temperate latitudes. Hence, the stability and antiquity of Tasmania's alpine karsts means that studies of their sediments, both above and below ground, is helping provide understanding of events that are of global significance, based on evidence that can be obtained from nowhere else on Earth. ■

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POSTER

THERMOKARST AT MARINE PLAIN, EAST ANTARCTICA

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PHOTO: BRENT FRASER

Ice Cave Entrance. Photo Competition First Prize for a Print in the Entrances and Other Surface Features category.

Thermokarst, a cold-climate form of pseudokarst, comprises irregular, hummocky terrain with closed depressions that appear similar to sinkholes but which are formed in very cold (periglacial) environments by the melting of permafrost ice in the ground and settlement of the sediments in which the ice occurs, rather than by dissolution of soluble rock as in true karst.

It is well developed in high northern latitudes but is rare in the southern hemisphere. The largest occurrence of periglacial thermokarst that has been recorded in East Antarctica occurs at Marine Plain (67°37'S, 78°9'E), a small basin of 4 km^2 that is filled with Pliocene marine diatomite sediments c. 9m thick which are overlain by thin glacial sediments.

Summer thawing of the ground at Marine Plain is confined to the upper c. 1 metre with the ground below this depth remaining permanently frozen.

The diatomite includes some very minor limestone lenses but dissolution of these does not appear to have contributed significantly to development of the pseudokarst landforms.

These landforms include thaw pits, thaw lakes, ground ice slumps, linear closed depressions and very small-scale beaded drainage features. Strong thermal conductivity adjacent to bedrock hills on the margin of the plain is an important process that has promoted progressive degradation of the subsurface permafrost by formation and back-wearing of low scarps, causing formation of the principal thermokarst landforms.

The existence of only small thaw pits away from the bedrock margins of the plain suggests the permafrost is probably closely in equilibrium with the present day climate and is undergoing only very slow degradation over a long time.

Human disturbance of the ground surface has locally thinned the seasonally-thawed surface sediments that form an insulating blanket over the deeper permafrost, and this has caused some accelerated melting and slumping.

Marine Plain was designated as a Site of Special Scientific Significance in 1987, primarily in response to the discovery of Pliocene dolphin and mollusc fossils.

Its significance as a thermokarst was not recognised at that time. It has recently been re-designated as Antarctic Specially Protected Area No 143 and a new management plan now recognises the significance of the thermokarst. ■

POSTER

SYNTHESISING STALACTITE MORPHOLOGY

Damian P. Marrick
IMAGEN Program, Level 2 South Pod, National ICT Australia, Bay 15, Locomotive Workshop, Australian Technology Park, Eveleigh, NSW 1430, Australia

Julia M. James
Heavy Metals Research Centre, Chemistry, F11, The University of Sydney, NSW 2006, Australia

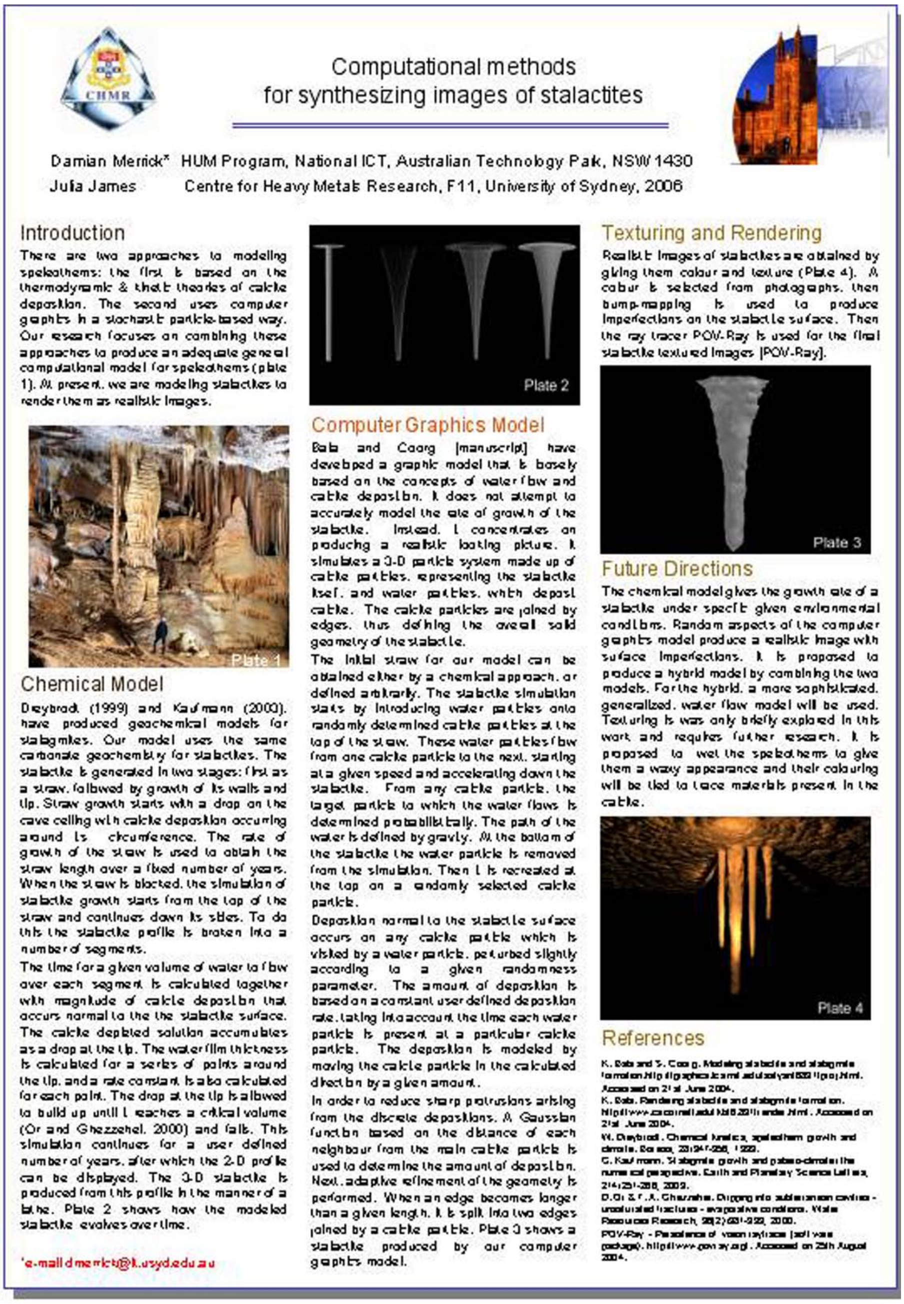
A topic of major interest in speleology is the morphology of speleothems. However, the chemical and physical processes that occur to form speleothems in nature are quite complex. Speleothem growth can be modeled computationally with the input of various parameters. One could easily explore the vast variety of potential shapes that may arise from different conditions in a cave.

Our research aims toward the goal of computationally modeling the morphology of speleothems. We have investigated two models for generating stalactite geometries, and rendered these geometries as realistic images.

The first of these is a rigorous model based on the thermodynamic and kinetic theory of calcite deposition. It first generates the shape of a calcite straw, based on a linear approximation of the rate of deposition. It then blocks the straw and builds up the sides and tip of the stalactite.

The second model is a stochastic particle-based approach from computer graphics. This model starts off with a cylinder, representing the straw speleothem, which is made up of calcite particles joined together by edges in the geometry. Water particles are generated at the top of the straw and allowed to flow along edges between calcite particles. Deposition occurs on every calcite particle visited by a water particle, according to the length of time the water particle is present there.

The water particles accelerate down the sides of the stalactite until they reach the tip, where they are removed, causing new water particles to be created back at the top of the stalactite.



Stalactites generated by both models were rendered as images with realistic texturing and lighting in a ray-tracer. Although the first model provided a more chemically accurate approach to generating geometry for a stalactite, the images produced by the second model appeared much more realistic. We aim towards a hybrid of these two approaches that may result in more realistic images.

LANDSCAPE EVOLUTION OF THE NARACOORTE KARST AREA IN THE LATE CAINOZOIC

Susan White
Victorian Speleological Association
John Webb
Dept of Earth Sciences, Latrobe University, Bundoora, VIC., 3086

The Lower Southeast of South Australia and a substantial part of southwestern Victoria is a limestone karst province, which comprises extensive areas where cave and karst development is limited, interspersed with areas of atypical intensive karst development such as at Naracoorte.

At Naracoorte dolines, uvalas and blind valleys characterize the surface karst. The caves range from simple single passages to complex multi-level mazes, and passages trend predominantly northwest/southeast. Cave walls and ceilings retain evidence of solutional features such as large non-directional scallops and bell holes. The caves contain a range of fossiliferous clastic sediments and dated speleothems. The fossils accumulated through pitfall entrances in several episodes during the Middle Pleistocene (100,000 - 400,000 years ago).

The development of the Naracoorte karst is constrained by the age of the enclosing Gambier Limestone (Oligo-Miocene), and probably is later than the maximum sea-level transgression at ~7 Ma. The following Pliocene-Pleistocene regression deposited a series of subparallel beach dune ridges, becoming progressively younger seaward.

Cave formation occurred in a relatively narrow window of time between uplift along the Kanawinka Fault in the late Pliocene, and the draining of the caves by a sea level fall at ~800 ka, when deposition of the West Naracoorte Range occurred. The main period of cave development began during deposition of the East Naracoorte Range at ~1.1 Ma, as prior to this the cave area was flooded by the sea, and no cave formation could occur. The caves may have initially formed along the freshwater/seawater interface extending inland from the East Naracoorte Range, and were subsequently enlarged by groundwater flow as sea level fell between 1.1 Ma and 800 ka. Because the water table was not stable for a substantial period of time, there was no preferential development of passages at a particular elevation.

The incision of Mosquito Creek postdates uplift along the fault and occurred during the period of sea level fall. As the water table dropped due to sea level fall and creek incision, the caves partially, then completely, drained. Most of the collapse that characterises many of the Naracoorte caves probably occurred progressively as the water drained from the passages; at least some collapse entrances could have formed at this time.

Solution pipe entrances have formed since the main cave development, intersecting the older main cave passages and enabling sediment accumulation. Cyclical wet and dry conditions occurred over the last 500 ka as landscape modification occurred throughout the Pleistocene to the present.

The overall landscape history of the Naracoorte area during the Pliocene/Pleistocene shows the speleogenesis was controlled by oscillating sea level, coastal deposition and tectonic movements on the Kanawinka Fault. This model integrates the cave morphology and the processes with the groundwater and long-term landscape data. ■

MIOCENE 10 Ma
Low Sealevel
Exposure of Gambier Limestone to subaerial weathering
Rise in sealevel at ~ 8 Ma

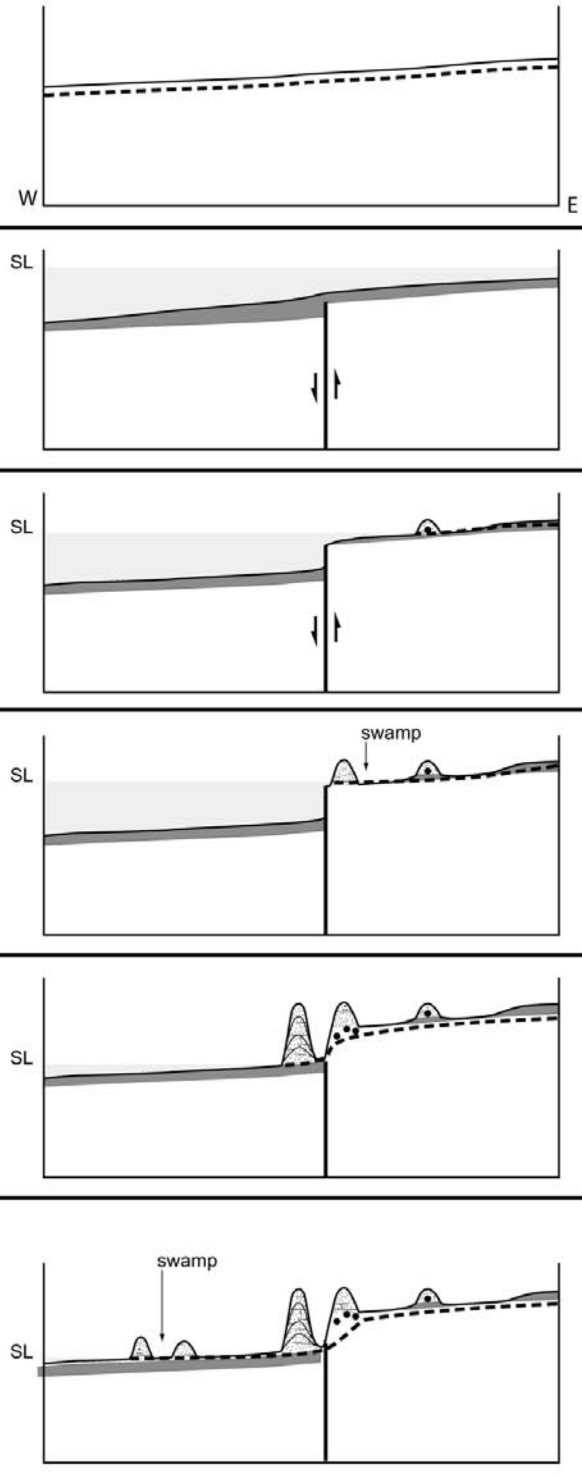
LATE MIOCENE - EARLY PLIOCENE 7 Ma
Maximum sealevel at ~7 Ma and deposition of marine sands
Marine regression after maximum sealevel
Deformation and uplift e.g Dundas Tableland
Uplift along Kanawinka Fault
Change from coolwater carbonates to slilcicalstics

LATE PLIOCENE - EARLIEST PLEISTOCENE 3 Ma
Marine regression continues
Deposition of carbonate strandline dunes e.g. Hynam Dune
Syngenetic karst in dunes is initiated

EARLY - MID PLEISTOCENE 1.1 Ma
Deposition of East Naracoorte Range as strandline coastal dune, except in the estuary of Mosquito Ck.
High groundwater level related to sealevel
Solution and initial conduit development especially in the estuarine area

MID PLEISTOCENE 0.8 Ma
Bruhnes- Matayama magnetic reversal
Sea level dropped and West Naracoorte Range deposited as 4 stacked dunes
Incision of Mosquito Ck
Water table lowering associated with drop in sealevel drains caves and collapse occurs

MID - LATE PLEISTOCENE 0.5 Ma
Regional uplift continues
Fluctuating sealevels but marine transgressions never return to West or East Naracoorte Ranges
Further strandline dunes deposited
Cyclic wet and dry phases
Solution pipes form
Caves fill with fossiliferous clastic sediments and speleothems
Small amount of collapse continues
Episodic flooding



Caves continue to be modified to the present day

Key: Kanawinka Fault; Water table; Cave; Pleistocene Bridgewater Formation; Pliocene Sands; Miocene Gambier Limestone

Landscape evolution of Naracoorte area since the Miocene.

A BRIEF HISTORY OF SURVEYING THE BULLITA CAVE SYSTEM

Bob Kershaw
Illawarra Speleological Society

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ABSTRACT

There have been snippets of geological and other information concerning Australia's longest cave published in various editions of the ASF's journal Australian Caver, *minor presentations made at overseas and ASF conferences over the years and a substantial trip report in* CEGSA News *(Volume 49 Number 11). Recently there has been an article published in* The Australian *newspaper as well as numerous postings on the Ozcavers email group. Further reading on the Bullita Cave System is listed at the end of the paper.*

The aim of this presentation is to provide a brief history of the results of the annual surveying of the Bullita Cave System and smaller adjacent caves during the numerous expeditions since exploration commenced 15 years ago. As a result of the initial work by PWC Rangers Keith Claymore and Keith Oliver followed by the Operation Raleigh Expedition of Smith and Storm from the United Kingdom in 1990 to the Top End Speleological Society (TESS) surveying and subsequent work by Australian cavers coordinated by TESS and Canberra Speleological Society (CSS), the Bullita Cave System is now just over 100 km in length.

INTRODUCTION

In Pre-European times the Victoria River Region was home to seven Aboriginal language groups: Ngarinyman, Ngaliwurru, Bilinara, Malngin, Nungali, Karangpurra and Wardaman. There were frequent and often violent disputes regarding tribal boundaries. It is the Ngarinyman that lived predominantly in the region of the caves.

European discoveries began in 1839 when Captain J. Wickham and John Stokes discovered, named and explored the Victoria River. Following favorable reports by Wickham and Stokes, Augustus Gregory (Figure 1) led the 'North Australian Exploring Expedition' in 1856-57 and followed the Victoria River to its source and recommended that the area be opened to pastoralists. In 1879 Alexander Forest traversed the Wickham River and at the beginning of the last century the Duracks had taken up grazing licences in the area.

In 1968 Arthur Clarke, while employed with the Bureau of Mineral Resources, worked in the area with geologist Sweet and an English geologist, John Mendum, who was there with his wife Mary. They explored quite a few caves and entrances in the course of their geological mapping of the area (Clarke, pers. comm.).

The area around Bullita had been used for cattle grazing until it was purchased by what is now the Northern Territory Parks and Wildlife Commission for inclusion in the Gregory National Park.

In the 1980s NT Parks and Wildlife Commission (PWC) staff, Keith Claymore and Keith Oliver, conducted a survey of the karst and found several entrances.

On 17th July 1984 the concept of The Gregory National Park was approved and the park was declared on 14th August 1990 making it the largest park in the PWC estate. Kakadu is larger but Federally administered.

There is now a new Bill before the NT parliament, the *Parks and Reserves (Framework for the Future) Bill 2003*. Basically,

Figure 1: Augustus Charles Gregory (1819–1905). (National Library of Australia).

if this bill is passed, it will return NT parks to the indigenous landowners who will lease back the parks to the NT Government on a 99-year lease. This act will provide "a framework for negotiations between the Territory and the traditional Aboriginal owners of certain parks and reserves for the establishment, maintenance and management of a comprehensive system of parks and reserves" (Office of the Chief Minister, 2003). This applies to Gregory National Park.

HISTORY OF EXPLORATION AND SURVEYING

The map at the end of the article (Figure 2) should be looked at to assist in locating some of the sites mentioned below.

1987

Two members of TESS made a brief trip to Limestone Gorge but no entrances were tagged or explored.

JULY 1990

Operation Raleigh Expedition of Smith and Storm (Storm & Smith, 1991) from the UK surveyed the following caves north of Limestone creek:

Tic Tac Cave with a length of 500 m, Lost Cave with a length of 1600 m

Birthday Cave with a length of 1700 m

Dingo Cave with a length of 1600 m

Later in this Expedition, two caves were surveyed that were adjacent to the East Baines River in the South of the region:

Jalaman Wangar Jarin Cave with a surveyed length of 1340 m and Claymore Cave with 6200 m of surveyed passage.

1991

A TESS trip located some caves south of Limestone Gorge (BAA 22, 23).

CSS initially mapped BAA 10-11 (Two Fishes, to a length of 4600 m).

1992

After an examination of aerial photographs, Guy Bannink and Karen MaGraith located BAA36, BAA37 and with Peter Bannink explored a major rift further south where the entrances to BAA34 and BAA35 are now located and tagged (Bannink, pers. comm.).

CSS members surveyed an area to the south of the southern block tagged BAA29 - 3900 m. CSS also surveyed the small area south of Limestone Creek, BAA37.

1993

TESS began exploring and surveying BAA35 in the central area of the karst with Tasmanian cavers Stuart Nicholas and Chris Davies.

A CSS expedition discovered "Berks Backyard" to the north of BAA35 and mapped their historic 11 km in one trip. It was named "Berks Backyard" as it was within reasonable walking distance from the campsite and because no one had found it previously and the ferns and trees gave it an aura of being in a garden (Brush, 1994).

1994

TESS was shown a cave by some members of the RAAF who were camped at Limestone Gorge, that was later referred to as "Raafies Cave", BAA50.

TESS and CSS overlapped their expeditions and together located and surveyed BAA51 entrance at the beginning of the "Neighbours Block", a cave system that was later connected to BAA50. BAA36 and BAA37 were joined and TESS connected BAA35 to "Berks Backyard".

1995

The three-person trip of Don Glasco, John Dunkley and Veronica Schumann surveyed 10 kms and joined "Berks Backyard" and "The Frontyard" proving an underground connection between two major karst blocks. Glasco commenced using the mapping procedures we still use today. (See the article on surveying problems in these proceedings). The passage length was increased to 29 km, making it Australia's longest cave.

1996

According to Bruce Swain and John Dunkley, CSS and TESS discussed splitting the exploration area. CSS would continue mapping and coordinating "Berks" and the karst south of Limestone Gorge and TESS would continue coordinating and mapping the area north of Limestone Gorge.

CSS resurveyed BAA35 and began work in the karst of the "Neighbours Block", probably resurveying the BAA50-51 area that TESS had surveyed and increased the passage length to 42 km.

In late March 1996 Arthur Clarke and Mick Williams, undertook an appraisal of the biodiversity of invertebrate species and species types from caves in warm temperate and tropical Australia (Clarke, pers. comm.).

They collected a range of species from caves north and south of Limestone Gorge.

1997

BAA36 and 37 were joined to the "Neighbours Block" and an area called "SWB" to the NW of "Berks Backyard" was added. An isolated cave called "Skeleton Key" was found and surveyed. Work continued in "The Frontyard". The total continuous surveyed length of passages was now 54 km.

1998

In that year, BAA 97, "SWB", was joined to BAA35 "Berks Backyard" and surveying commenced in BAA34 taking the length of the cave system to 60 km.

1999

BAA 34 was extended and a new but isolated area "SOGS" (Silly Old Goats) named in honour of the silly old fellows Nicholas White and Lloyd Robinson who continually walked over the area. Lloyd and Nicholas also found a resurgence from the SOGS system but that was not surveyed until 2003 because it was impossible to enter. The length of the system was now 65 km.

2000

Work continued in BAA 34 and to incorporate short days in between long walks, "fill-in" work in the "Neighbours Block" occurred bringing the cave length to 76.5 km.

2001

The year of the "Space Odyssey" and many days work joined "SOGS" to BAA34. We relocated an entrance discovered by Michael Coopes and Bruce Swain in 1999. It was named "Mikes Cave" in honour of Michael Coopes after his death in an accident in Switzerland. We found a new entrance in what is called NW SOGS and a drain at the bottom of what is a multi-level (5 level) area that headed in the direction of the resurgence. More "fill-in" in the "Neighbours Block" extended the cave length to 80.5 km.

2002

A great deal of work in BAA34 and NW SOGS around "The Drain" took the total length to 85.8 km

2003

The survey teams joined three previously isolated caves, Skeleton Key, Mikes, The Drain and then the Efflux of SOGS, into the Main Bullita Cave system. During the last few years, members of the expeditions assisted Bruce Swain, from TESS, with a survey on the north side of Limestone creek. The distance now was very close to 93 km (Sefton, 2004).

2004

Exploration to the NW of Mikes Cave and following up leads left in the Hermitage Grange area that had been surveyed in 1993. Another 1.2 km in the SOGS region was surveyed. A new isolated cave south of SOGS, "Wadija Cave", was surveyed to a length of 1.3 kms.

An important milestone in the Bullita Cave System was reached at 4.45pm on 15th July 2004 (the last day of the 2004 expedition), when Station "04100km" was constructed to celebrate the 100.03 kms of surveyed length.

THE FUTURE

A great deal of exploration and surveying will still have to be completed if cavers continue to follow the requirements of the NT Parks and Wildlife Commission Permits and traditional landowners' wishes.

Please see the letter that is attached as Appendix 1 that was published on the 'Ozcavers' forum in response to several enquiries regarding the Bullita Cave system in July 2004.

ACKNOWLEDGEMENTS

I would like to thank Bruce Swain of the Top End Speleological Society, John Dunkley of the Highland Caving Group and Peter Bannink for their assistance in producing this history and Albert Goede for his assistance in revising the article.

Thanks also to the following NT Parks and Wildlife Commission Rangers for their support either in the field or in an administrative capacity over the past fifteen years:

Claymore, Keith
Oliver, Keith
Anderson Mark
Carter, Dane
Connor, Nathan
Fisher, Garry
Hartwig, Andrew
Jones, Sarah
Nicholson, Steve
Michael ?
Kerin, Sarah
Perry, Justin
Playford, Luke
Schmidt, Cate
Scoot, Barry
Sharpe, Cameron
Washburne, Sam
Williams, John
Woodward, Mark

We need to acknowledge the achievements of a dedicated group of cavers from various expeditions who helped in achieving the successes over the years. *Our apologies to anyone that may have been inadvertently left off the lists below.* The surveyors are:

Explorers/Surveyors from TESS:

Bannink, Guy
Bannink, Peter
MaGraith, Karen
Swain, Bruce
Jacups, Susan
Finke, Craig
Connolly, Scott

Expedition members:

Abbott, Doug
Anderson, Carol
Anderson, Neil
Bradley, Chris
Bradley, Lisa
Brush, John
Campbell, Jim
Campbell, Nikki
Carmichael, David
Cashburn, Jean
Coggan, Marjorie
Davies, Chris
Dunkley, Jeanette
Dunkley, John
Dunn, Bob
Elton, Judy
Epsen, Tim
Fitton, Coral
Fullager, Fred
Glasco, Don
Goede, Albert
Hite, Norm
Hunter, Debbie
Ingeme, Yvonne
Jambrecina, Mim
Kershaw, Bob
Madris, Melissa
Martini, Jacques
Nicholas, Stuart
Nosworthy, Andrew
Papp, Eve
Poulter, Norman
Poulter, Robert
Poulton, Fran
Randall, Bru
Redpath, Carol
Redpath, John
Robinson, Dorothy (camp)
Robinson, Lloyd
Schomer, Barbara
Schumann, Veronica
Sefton, Mark
Taylor, John
Veness, Tony
Wall, Andrew;
Wellington, Bob
Wellington, Pru
White, Nicholas
White, Sue
Woodcock, Gary

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Web Site: http://www.ausemade.com.au/group/c/caves/caves.htm

APPENDIX 1

LETTER FROM BULLITA EXPEDITION MEMBERS TO AUSTRALIAN CAVERS

(as sent to Ozcavers in July 2004)

We are sending this item in response to several postings recently, following unsolicited publicity in *The Australian* newspaper about Australia's longest cave in the Northern Territory. These 'Ozcavers' postings were quite inaccurate, but our brief here is not to take issue with the authors, but to acquaint you with the background.

First, we are rather surprised at claims by a few cavers that there is something secretive about this project. It has in fact received much more publicity than successive expeditions to remote parts of northern Queensland and Western Australia, for example, but as in those places, there are sound reasons for exercising caution when the mass media become involved. *The Australian* also carried a report and photograph back in 1997, so there is really nothing new reported.

The mass media may think otherwise, but there is nothing secretive about our project within the caving community. Over the last decade, progress reports have been presented to at least 3 ASF and other conferences, with some 7 or 8 publications (including cave maps) in at least 4 or 5 different journals, proceedings and club newsletters. For the record, the most recent were in *Australian Caver* 160 in December last year, and a lengthy article in *CEGSA News* in February 2004.

This has been a genuinely national project, but it is not controlled or organised by ASF. Initially organised by CSS & TESS, the project has for a decade been open to members of other clubs prepared to accept the expedition conditions, although there is a practical limit of 12 to 15 people for logistical reasons. More than 60 individual cavers from at least 11 different ASF member clubs in every state and territory except Queensland have assisted with the exploration and surveying over a period of more than 13 years. To our knowledge, all offered their services of their own volition - they were not approached to do so.

However, participants are bound by the conditions of access set down both in the Permit and in writing by the land managers, which include not publicising the work we do, nor publishing any of the results without their prior permission. Management has several reasons for this including risk management in a remote area with limited resources, sensitivities of Aboriginal communities and, until very recently, the absence of a Management Plan.

<u>Aboriginal communities</u>

Next, we feel that cavers generally need to be more aware of the sensitivity of Aboriginal communities to people wishing to enter their lands. At the ASF Conference in Bathurst in 2001 a guest speaker from the local Aboriginal community stressed these sensitivities strongly in his address.

Most cavers live in southern Australia and are accustomed to liaising with managers and private landowners in places where Aboriginal rights have long been extinguished either by the land tenure system or by effluxion of time. We sense that they may not appreciate that it is different in the North. Throughout northern Australia, and particularly in the Northern Territory (where over half of the land is Aboriginal), traditional landowners (i.e. local Aboriginal communities) have sensitivities, powers and rights on both public and Aboriginal land (including statutory rights) that they generally do not enjoy in other states. Most Australians are aware, for example, that entry to Aboriginal land generally is on a permit basis, and that commercial photography of icons such as Uluru is at the discretion of the traditional landowners, who also dissuade visitors from climbing the Rock.

Clearly, land management authorities must abide by statutory requirements in this regard, and in turn so must we.

<u>ASF Code of Ethics</u>

In considering how to let fellow cavers know what has been happening, we have meticulously followed both the conditions of access, and the ASF Code of Ethics, which includes the following clauses:

"2.1 Landowners, tourist guides and any person representing a management authority will be treated with courtesy and respect.

'4.4 Consideration should be given before publishing an article disclosing a cave's location, as to its intended audience, the wishes of the landowner and/or management authority, and the subsequent effect on the cave."

The managing authority for the area in question is the Parks and Wildlife Commission of the Northern Territory. Like other public authorities, the Parks Service allows entry to caves only under permit.

Furthermore, as elsewhere in Australia, there is also an expectation that visiting cavers will contact and cooperate with the member club that is documenting the area for the Australian Karst Index, which in this case is Top End Speleological Society.

<u>Whose right to know?</u>

There is always going to be debate between those seeking an unfettered right to know and those wishing to manage their land in accordance with their statutory rights. In general, cavers have accepted that land owners have final say in who is allowed on their land, under what conditions, and what is said about it either among the caving community or to the public at large. Even in NSW, for example, books on caves have omitted maps and location information on wild caves, even though that reduced their effectiveness as sources of information, because managers and/or landowners requested it.

Cavers and other visitors simply must accept the fact that in the North, the rules are different, and have more consideration for those of us trying to negotiate access. Conditions of entry for activities like caving are just not as open or as straightforward as you are accustomed to in southern Australia. They may have been in the past, but they aren't now. For example, several significant caves and karst areas in the Kimberley and in north-west Queensland were explored by cavers in the 1970s and '80s. They are now closed off. In 2003, access to one major area was denied to cavers after arrival, even though the managing authority was previously willing. If these areas are ever to become accessible again, speleologists must accept these facts of life, and demonstrate a track record of respect for the wishes of owners. Although we have issued warnings in previous years, still neither *The Australian* newspaper, nor the recent postings to 'OzCavers' appear to recognise reality.

Ours has been the most successful focused program of exploration and surveying ever undertaken in Australia, and the outcome is world class.

It is only natural that some of you will feel you have missed out on something big. But, as we said, more than 60 cavers have already taken part. It's not a closed club. We will seek permission to present another progress report at the ASF Conference in January 2005, and members should then feel free to ask more from our group. In turn, we ask that even if you disagree, you accept the wishes of the managing authority relating to publicity, be patient, and not vent your frustration on us.

It's not secrecy, it's respect for the rights of others.

John Dunkley
Bob Kershaw
Bruce Swain
Mark Sefton
Nicholas White
Susan White
Debbie Hunter
John & Carol Redpath

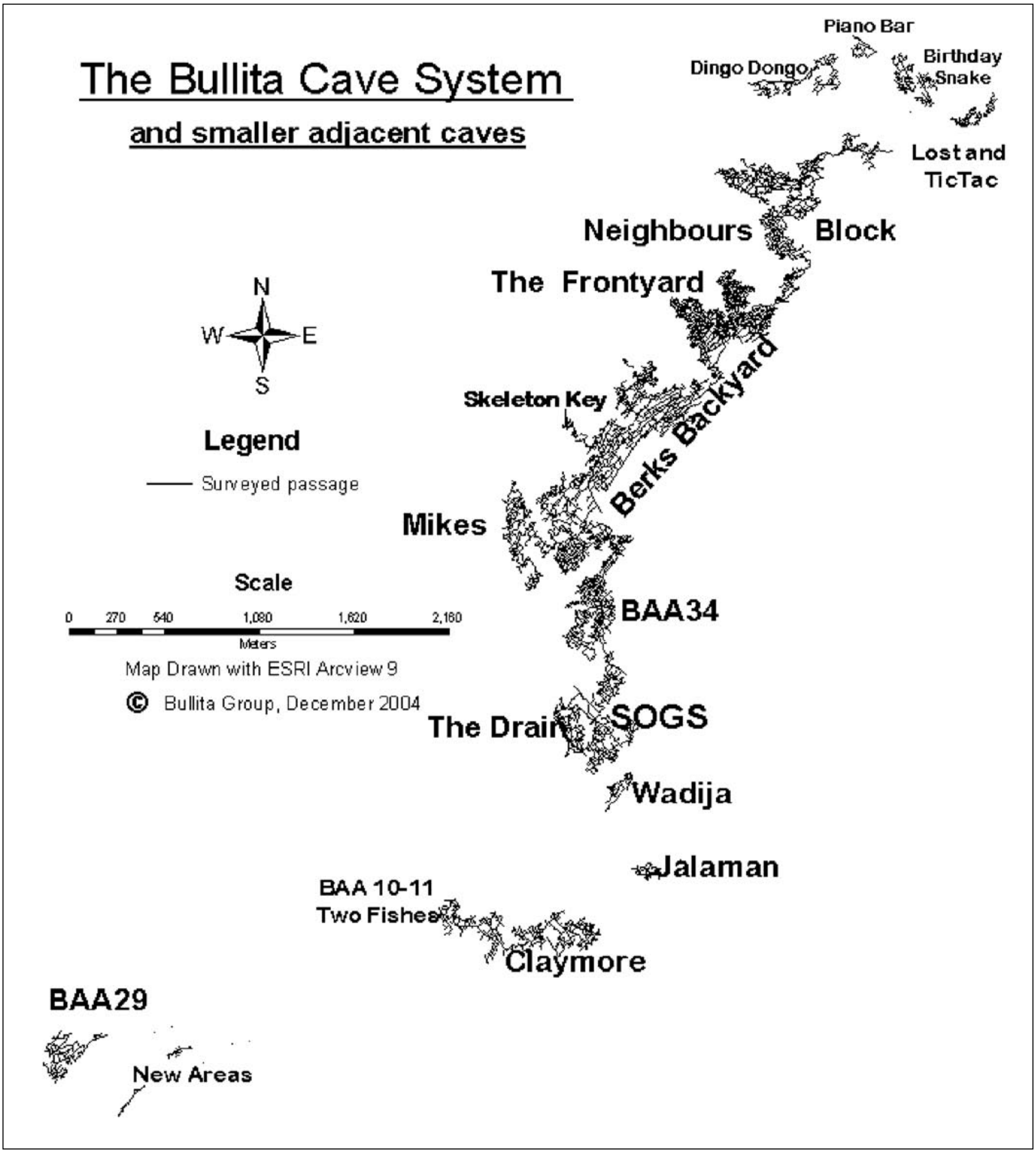

Figure 2: The Bullita Cave System.

EXPLORATION AND SURVEYING IN LECHUGUILLA CAVE 2002 - 2004

Jenny & Gary Whitby
48 Park St Charlestown NSW 2290

PHOTO: GARY WHITBY

Big Mothers of Pearls, Mother Lode Chamber, Lechuguilla Cave, New Mexico USA.
Photo Competition First Prize for a digital photograph in the Cave Decorations, Formations and Deposits category.

Spanning three expeditions over the last 26 months, two Australians have participated in project trips into Lechuguilla Cave, New Mexico, USA spending a total of 23 days in the cave.

This cave is different to most as it was eroded by highly corrosive sulphuric acid, created when hydrogen sulphide gas rose from deep underground pools of oil to mix with surface water leaching downward.

The unique conditions of Lechuguilla have been ideal for the growth of extraordinarily large and well-developed speleothems.

The result is one of the most aesthetically beautiful, mineralogically and geologically diverse, and challenging cave systems to explore in the world.

The known length of this cave today (November 2004) is over 184 km, and at a depth of 489 metres, it is the deepest cave in mainland USA, and is the fifth longest cave in the world. The expeditions featured in this presentation were are all to the Western branch of Lechuguilla Cave. As a result of these trips 3.1 km of new passage was discovered, surveyed and inventoried, and 2.0 km was resurveyed. There are still many leads left for future expeditions. The presentation gave an insight into experiences and sights of exploration in Lechuguilla. ■

LAVA CAVES OF THE BIG ISLAND, HAWAII

Jenny & Gary Whitby
48 Park St Charlestown NSW 2290

PHOTO: GARY WHITBY

Lava Tube, Olaa Section, Kazamura Cave, Hawaii, USA. (At 65.5 km it is the world's longest lava tube).

The Big Island of Hawaii is home to the longest lava caves in the world. In 2003, a group of ASF cavers had the opportunity to participate in survey and exploration of several systems on the island.

This presentation featured visits to some of the caves in the north west, south west, and eastern parts of the island including the two longest lava tubes in the world being Kazamura Cave, at over 65.5 km and Kipuka Kanohina (Kula Kai Caverns) at 22 km.

Virtually the whole island of Hawaii is in a hazard zone as judged by the United States Geological Survey (USGS). The USGS scale for the island runs from 1-9, with higher number designations given to areas lying further from active eruption zones. The lava caves we visited were in a "zone 2" hazard area.

Hawaiian lava caves are difficult to survey in, as they contain magnetite and hematite in large enough concentrations to affect compass readings. The caves are braided and maze-like with multiple levels and confusing passages, and contain unusual lava formations and secondary deposits. Evidence of ancient habitation and Hawaiian artifacts have also been found in these caves. This presentation was a slide show featuring the ten days caving and surveying in these unusual and sometimes surprisingly colourful lava caves. ■

LECHUGUILLA
– AN EIGHT DAY EXPEDITION

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Crystal Tree. Photo Competition Third Prize for a Digital photograph in the Cave Decorations, Formations and Deposits category.

INTRODUCTION

Lechuguilla is considered by many cavers to be one of the most beautiful caves in the world. It lies under the Guadalupe Mountains in New Mexico, close to Carlsbad Caverns tourist cave. The entrance of the cave chamber has been known for many years. However, it was not until the mid 1980s, after several digs through rock "air holes", that the cave opened up to eventually become one of the greatest cave discoveries of the twentieth century. The known cave is now 184 km long and 457 m deep, making it the third longest in the USA and the deepest on the US mainland.

I first heard of "Lech", as it is often called, in the mid-1990s, and soon after saw the book *Lechuguilla - Jewel of the Underground*. At the Hamilton ASF conference, I saw a video film of a major rescue of a caver from Lech. It was about then that I decided to add a visit to Lechuguilla Cave to the list of experiences I wished to achieve in my lifetime!

After a few inquiries and discussions with US cavers I discovered that the chances of a caver from Tasmania getting into Lech were virtually nil. Access to the cave was highly restricted and full of political in-fighting, so much so that the cave was closed for a two-year period. For some time, the only access seemed to be by "lot" – hoping your name came out of the hat. I even heard rumours that this lot was rigged. For a few years I put my Lechuguilla project on the back burner. Just then I found that Jeff Butt had managed to get a trip in.

He just happened to be in the right place at the right time. Soon after, I hosted Peter and Anne Bosted - two American cavers renowned for their cave photography. I spent a fortnight taking them around some of our best caves. Peter & Anne seemed to get reasonably regular trips into Lech, and managed to get an invitation for Jenny & Garry Whitby of Newcastle and Hunter Valley Speleological Society to join an expedition.

Around this stage the "politics of Lech" were changing. More often private expeditions lead by well-accredited cavers were gaining permits. The Lechuguilla Exploration and Research Network (LEARN) was still active and still relying on the "lot" method, or who you know. Jenny and Garry managed to impress the US cavers enough to x't a second invitation for an expedition in 2003 and then mentioned that they knew of a crazy Tasmanian caver who would be keen to join them. I was most fortunate that, through my relationship with Peter Bosted and the Whitbys, I was invited to join the October 2004 expedition led by John Lyles and Peter Bosted. The invitation arrived in adequate time to allow me the opportunity to prepare and arrange time off work.

PREPARATION

Planning for eight days caving in a cave halfway around the world is a considerable undertaking. Jenny & Garry's advice was invaluable. My biggest challenge was adequate light. I had previously made up a 'sewer light' for an caving visit to Iceland, however the globe used still chewed up batteries. Just in time, a new technology was released called "Everled". These globes are LED-based, but many times brighter than ordinary LEDs, and have a regulator built into the housing, so they just slip in as replacement globes without any alteration to the basic light design. I tested this system on a large cave like Kubla Khan, and found it more than adequate. My first set of 3D cells lasted 34 hours! Back-up lights were also a variety of LED based lamps, all taking AA size batteries to be compatible with all my flash & camera gear.

The next challenge was to cope with the cave conditions. Lech experiences 20 degrees Celsius and 99% humidity most of the time. By Tasmanian standards that is very hot, especially on exertion. I have caved in similar conditions in China and South Australia and found it very uncomfortable. For Lech it was a case of "Coolmax" shorts and tee shirt, and good elbow and kneepads to lessen injuries. A good collapsible water container, both for each day's outing from camp and to store water at camp was also essential. For storage I used wine cask bladders, and for each day - a collapsible hydration bag with tube and valve.

Another challenge was photography. I knew that this was a "work party" and my job would be surveying. This meant that there would be little time to take photos. How could one go to Lech and NOT take photos? Weight and a quick set-up was the principle that led me to decide to "go digital"; something I had only dabbled with previously in caves. Due to the high humidity I purchased a waterproof housing, which added bulk and weight but would ensure the camera did not fail. I also carried two flash units with Firefly slaves. Despite having been sealed in plastic bags, the humidity wrecked one flash unit. Although I prefer to spend time setting up for a good cave photo, I decided due to weight considerations, to dispense with a tripod and hope that others would have flash units available to assist with lighting up large areas. I was severely disadvantaged from a photographic point of view: a new camera, no tripod and minimal flash units. Also, I was a volunteer surveyor and any shots would have to be quick efforts.

Food was another huge challenge: enough for eight days, light weight, able to handle humidity and easy to cook. Our expedition leader offered to purchase "Mountain House" freeze dried meals, so I opted for a two-person pack for each evening meal, and packed muesli and dried milk for each breakfast. I made up a "scroggin" mix of chocolate, cashew nuts, sultanas, dates and dried fruit in lunch bag lots, plus of course a few snack bars to ensure I did not starve. I also carried 500g of staminade to ensure adequate electrolyte replacement.

GETTING THERE

I met with the Whitbys at Sydney airport and we flew through to Los Angeles. Here I discovered that my backpack was still in Melbourne, which is a bit distressing as all that technical gear would be very difficult to replace quickly. I made arrangements for my pack to follow me to El Paso (Texas) and fortunately it duly arrived 24 hours later.

We hired a car and drove to Carlsbad, staying with caving friends overnight before heading up into the Guadalupe Mountains to Carlsbad Tourist Cave and checking into the cave research huts where the whole group would be meeting. To fill in time the Whitbys and I arranged a free self-guided tour of Carlsbad, which is huge and takes about 3.5 hours.

TRIP PREPARATIONS

Every member of an expedition into Lechuguilla has to fill in all sorts of "Parks" paperwork and is in-effect a volunteer worker, covered by workers' compensation. We were required to view an extensive PowerPoint presentation about the cave, with the standards of caving, camping, water collection, surveying, etc being spelled out. The Parks staff seemed genuinely appreciative of the work of cavers done within the cave, but stressed that all survey data and inventory would become the property of the Park (and in effect cannot leave the Park).

CONDITIONS IN THE CAVE

Lechuguilla is a serious trip with many pitches and considerable climbing. The psychology of not knowing what lies ahead does make it somewhat daunting. I had read about "Terror Traverse" and heard stories of some very difficult sections, but frankly most of the "trail" through to the Western Borehole section is pretty easy BUT with a 22 kg pack on your back, it becomes a hard and very hot trip. It took six hours to get to the campsite at Deep Secrets. The cave IS hot, which means carrying plenty of water, and drinking continually – that adds considerably to the weight one has to carry.

There are severe restrictions on where water can be collected in the cave, and how this is done. The principle is to minimize any possibility of contamination as this could be disastrous both to the cave environment and to further expeditions. A jug is in place some distance from the water source – only this is used within the pool, then carried some distance to your water container area and must not touch your container while decanting. Fortunately water was available only ten minutes from the campsite, so each day empty containers were left for a refill on the way back to camp.

The campsite managed to accommodate all twelve of our group. Camp consisted of spreading out a plastic ground sheet, then a thermorest sleeping mat, and then a sleeping bag. All cooking, eating etc is done over the ground sheet to ensure no foreign particles are left in the cave. The toilet area was about 100m from the camp, with urine stored in wine cask bladders or similar containers and faeces double-wrapped in plastic bags. Some cavers seemed more sensitive to the smell than others.

Visiting the toilet involved covering boots with plastic boot covers so as not to transport any foreign bacteria or whatever back on to the trail.

ACTIVITIES

Each day (without a sunrise!) parties of four cavers would be assigned to an area to survey. Each party was lead by a sketcher, with one member responsible for all inventory recording (everything between stations), someone "on point" setting up survey stations and doing back-sights and someone on instruments. No "scooping" was allowed - a term used for checking out leads for some distance ahead without surveying them. Our expedition worked in the Western Borehole area, with groups being given either a specific area to follow up known leads, explore further and sometimes check survey errors from previous expeditions.

By 2004 all of the easy surveying had been done! Hence most of the surveying I was involved in was in fairly tight, sometimes gnarly type passages. "Work sites" were sometimes 2.5 hours away from camp, and at times involved negotiating several pitches or climbs. Most days involved between 12 and 16 hours of caving, often depending on how much new passage was discovered and how enthusiastic the group was to survey it. In all, our expedition added 1300 m to the cave and re-surveyed almost 500 m.

Unfortunately there was little time for serious photography, with most photos taken while en route to the work area or returning. This severely limited the time that could be spent setting up a shot, but I had to accept that I was there to work. Each day's walk west took us past Lake Louise, our water supply and along the same route for at least an hour, so very quickly what had been some considerable effort on the first trip out along the bore hole, involving several handlines, two vertical rope climbs, a crawl and a very long "trog" soon became very familiar, easier and less sweaty! I guess I was getting fitter and more acclimatized.

LESSONS LEARNED/PERSONAL OBSERVATIONS

I found the heat and humidity very difficult to get accustomed to, especially when involved in considerable physical exertion such as prussiking or caving with a full pack. My pack with all food, spare batteries plus normal caving and vertical gear, weighed about 22 kg. Caving with such a weight is about six times more difficult than caving with a daypack! However the heat had its compensations. I never felt cold, although sometimes others did.

The pitches were easy with no rebelays, and most climbs and traverses only became a challenge because of the weight and bulk of gear being carried. I found I drank about 3 litres each day, but my appetite was greatly reduced, possibly because of the heat. At one stage I thought: "this is great; I'll loose heaps of weight" (but have to carry out a lot of food), but then I worried about keeping up enough energy. Usually I ate virtually nothing between breakfast and the evening meals (sometimes after midnight). It is so different to caving in cold Tasmanian caves.

Flagging tape is used throughout the cave for several reasons:

1. To mark both sides of the trail, limiting the damage of caver traffic and marking all turnoffs and survey offshoots. This makes navigation very easy on "the main drag".
2. To leave permanent survey stations, with the survey series numbers system unique to each survey leg and a definite point as the actual survey mark.
3. To mark off very delicate areas or special features – this alerts cavers to be particularly vigilant and also provides the ability to relocate features such as fossils.

Surveying and drawing is done to a very high standard. All sights are done as forward and back sights with the expectation of a measurement error of two degrees or less. Distances are done by Laser Disto, measuring twice to reduce measurement error.

The inventory is extremely extensive, involving walls, floor, room, biology, types of speleothems, all crystals and many other features (frankly to do it properly you would need several geology-related degrees). On "point", one would only scout ahead for a short distance before deciding to survey as great criticism has been leveled at previous explorers for scooping and then not bothering to survey (many great leads have remained undiscovered because of this). My team's greatest effort was 500 feet of survey in one day, breaking into a whole new section of cave at about 21:00 hrs – we didn't return to camp until 03:00 hrs, leaving more surveying to return to.

When checking previous survey errors it was easy to be critical. In the early days when walking passage was involved, with survey legs of over 100 feet, no back bearings and a mad rush to find more big cave, standards were certainly compromised. (Some survey stations were not marked, making relocation impossible).

The cave has an airlock near the entrance to maintain the conditions that existed before the dig through. The cave is also left rigged on all handline traverses and vertical pitches – some vertical leads have only been examined once but a rope is left in place in case further investigation is required. Overall, I was very impressed with the "management" of the cave. A huge effort has been made to protect as much as is practical from human impact, or at least limit damage to the main trail and certain other areas.

Standards for collecting water, camping and toilet regulations are strict to minimize human impact and contamination. Camping sites and water sources are severely limited. The survey standards are high and applied in such a way as to minimize the possibility of requiring re-survey and hence more caver impacts.

Without extending this article into the complex geology of the cave, Lechuguilla has some incredible secondary deposits that are almost unique: gypsum bowls 1 m across, dogs-tooth spar about 25 cm long, chandeliers 4-5 m long, mammaries and aragonite trees up to 2 m high. I am sure my photography has not done it justice.

I feel Australians would do well to adopt many of the standards set for cavers in Lechuguilla, particularly in potentially extensive and/or well-decorated caves. When it is done right the first time it will pay great dividends both for the cave and cavers in the future.

Lechuguilla is certainly one of those "trips of a lifetime". I felt privileged to have been able to experience at least some of this wonderful cave for eight days. ■

KARST IN THE WEST KIMBERLEY – AN OVERVIEW AND UPDATE

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PHOTO: ROSS ANDERSON

Kimberley Panorama.

ABSTRACT

The Kimberley region in WA contains several significant karst systems. This area has been the focus of several intensive speleological expeditions. Since the mid 1900s several speleological groups have undertaken trips to this area. The expeditions have had the goal of documenting and recording the karst values of the area. The WA Speleological Group (WASG) is one such group that has undertaken speleological studies in the Kimberley.

It is essential, not only that speleological research is documented, but also that information is kept in a central area. It is also seen as important that the speleological groups in Western Australia are aware of trips occurring to the region, and of outcomes. This will assist in the co-ordination of information and ensure that valuable volunteer time is not wasted.

The main speleological expeditions/trips that are known to have occurred to this area are outlined. What is currently known about the karst in the Kimberley is discussed. Some recent discoveries and useful techniques of recording information are outlined. The potential for future visits and documentation of karst in the Kimberley are explored.

INTRODUCTION

In general, the limestone in the Kimberley occurs as a Devonian reef complex expressed as a series of ridges. The ridges run NW-SE for about 296 km along the northern side of the Fitzroy River Basin, fringing the Kimberley Plateau. Figure 1 shows the primary Limestone Ranges of the West Kimberley.

There have been numerous speleological expeditions to the Kimberley. From our research it appears that the 1960s and 1970s were a very busy time for cavers from all over Australia to visit the Kimberley. During this time the Illawarra Speleological Society (ISS) undertook six trips – mostly to the Laidlaw/Lawford Ranges karst area. References to these trips and more details will appear in *The Western Caver* (Anderson 2005, in prep. b). Robinson (2004, pers.comm.) stated that nearly all of the trips to the Kimberley were unrecorded. This is believed to be due to an agreement that ISS had with the landowner not to publicize or document the area. In total, ISS has undertaken 11 trips to the Kimberley, the majority of trips being to the Cave Springs/Mimbi area.

Western Australian cavers undertook numerous trips to the Kimberley karst areas. Speleologists like Jennings, Sweeting, Lowry, Davey, Jolly and Playford all visited the area numerous times. Many of these trips were not individually recorded – however the information gained was utilized in scientific papers and further documentation of the area. The authors are preparing a paper with more details to appear in *The Western Caver.* This will contain a list of the WA led expeditions that the authors are aware of from documented literature. It will also contain references to other non-WA speleological groups who have visited the Kimberley (Anderson in prep. b).

It has been known for some time that the limestone ranges of the west Kimberley are of considerable international significance both geologically and geomorphologically. Davey (1980) stated that *"the karst in the west Kimberley must be regarded as one of the most diverse and scientifically interesting – not to mention scenically impressive – of our scarce Australian karst resources"*. Davey also pointed out that unfortunately the remoteness of the limestone ranges from the main centres of the Australian population has significantly inhibited systematic exploration and documentation of the karst, and of caves in particular. The remoteness means that travel to the area takes at least 2-3 days driving from Perth and 4-5 days driving from the east coast. Visits to the karst areas in the north require considerable finances, planning, organization, time and of course "keen cavers"! The positive side is that the area has not had the same environmental impact by recreational cavers as karst areas located closer to places like Perth or Sydney.

Some of the caves in the west Kimberley have been recorded since the turn of the 19th Century. The Kimberley's three best known caves (The Tunnel, Old Napier Downs Cave and Cave Spring Cave System) have been fairly thoroughly investigated (Jennings 1962, Jennings and Sweeting 1963, Lowry 1967, Shannon 1970). In 1973 Bridge listed a total of 33 caves and karst features that were documented in the literature at the time. Other authors (Cox and Dohnt 1971, Nicoll 1977, Shannon 1970, Dicker 1978) describe previously unknown caves, which illustrate the potential for further discoveries in the region (Davey 1980). The WASG 1996 trip (Vine 1997) added about 70 "new" caves and karst features to the known caves of the Kimberley.

Davey (1980, p 41) has stated that *"it must be stressed that many features of the limestone ranges are of considerable international significance, and that the area is an outstanding component of Australia's natural heritage"*. Of particular concern to the authors is that many of the ASF recommendations regarding the significance and protection of the Kimberley karst (when the ASF commented on the WA Dept of Conservation and Environment Report on the "Conservation through Reserves Committee" on System 7:The Kimberley") have not yet been resolved. Although important parts of the ranges are contained in National Parks (eg Windjana, Geiki Gorge, Tunnel Creek) there is little acknowledgement or management of the area's karst. The authors note that the WA Government primarily operates the National Parks as "surface" environments for tourism, and management of visitor impacts in tourism nodes. The IUCN outlines the need for Integrated Catchment Management. It is the IUCN Guidelines for karst management, which highlight the importance of what is referred to as a "total catchment regime" (Watson et al 1997). The Kimberley region requires an integrated management approach, such as integrated catchment management.

This paper does not describe or outline the significance of the karst in respect to its geology. This has been discussed in detail in numerous papers (Davey 1980, Jennings 1962, Jennings and Sweeting 1963, Playford 1960, Playford 1976, Playford and Lowry 1966, Teichert 1949, Playford 1976, Logan and Semeniuk 1976). Nor is this paper in any way attempting to describe the significance of the karst area's subterranean biota. The WASG web site (www.wasg.iinet.net.au/kimberley.html) notes that most cave fauna of the region has been collected by two expeditions – the WA Museum (WAM) and Bill Humphreys' 1994 (Humphreys 1995) and the WASG 1996 (Vine 1997) expeditions. The most recent WASG expedition (Anderson, in prep. a) has also undertaken cave fauna sampling.

Davey (1980) stated that there has not yet been any systematic study of the cave dwelling bats of the region. He also noted that Hamilton-Smith had claimed that many basic questions about the bats of the west Kimberley karst and caves remain unanswered (Hamilton-Smith 1966). As Davey noted however, this *"lack of information is indicative more of the rarity of visits to the area by interested and qualified researchers than any scarcity or impoverishment of the caves invertebrate fauna"* (1980:37). The authors point out that further study and documentation of the west Kimberley subterranean fauna is needed. Jennings (1962) stated that he considered *"the west Kimberley caves to be virgin ground for the bio-speleologist"* (1962:33). To date, the authors are only aware of three expeditions to the West Kimberley to collect subterranean fauna for the WA Museum (Vine 1996, Anderson in prep. a, Humphreys 1995).

Davey (1980) also stated that there is little published research on the palaeontological and archaeological aspects of the caves. He cites work done/undertaken by Nicoll (1977) and Gorter and Nicoll (1978) and Playford (1960). Even since that time, studies of the area have only been of a reconnaissance nature.

In the 1980s there were several expeditions to the Gogo and Mt Pierre Stations, East of Fitzroy Crossing. Significant fossils were found at several sites that are believed to be in the Devonian reefs of the Laidlaw/Lawford ranges and referred to as "Cave Springs". This area also contains the Mimbi Cave system.

McKenzie (2004, pers. comm.) has indicated that there was a recent Government expedition to the area – primarily concerned with live mammal trapping, but also examining caves and cliffs for subfossil deposits. O'Donnell (2004 pers. comm.) stated that the group of CALM scientists found a thylacine jawbone near the Cheddar Cliffs.

Davey's closing comments are that *"the limited features identified so far are of considerable interest and it is very likely that there will be significant discoveries in the future. As such, resource management must be sufficiently flexible to protect new sites as they are identified"* (1980:37). He also said that *"the impression remains that much of importance remains to be discovered, documented and protected"* (1980:37). It is now 25 years later and this statement is still true!!

Jennings (1962:30) stated that *"in the dissected limestone country, dark cave entrances invite the caver on every hand. Indeed, there is much first exploration to be done by visiting speleologists."* (He went on to say that *"unfortunately most will probably prove to be small caves"*). The authors note that the nature of the karst, with its dissected fissures has nevertheless provided some extensive cave systems. More recent exploration has found extensive network caves and extended the known sections of caves. For example, KN1 was surveyed in 1959 (Jennings 1962) and the cave was later extended on several occasions. It is the authors' opinion that there are still large caves to be found. Although it must be noted that the definition of "small" and "cave" are relatively subjective.

In 1995, Humphreys reported that *"few caves have previously been reported from the Devonian reef system, however… there is a large number of caves in the Devonian reef system. Some are substantial and contain extensive decoration. In addition there are significant caves in sandstone country"* (Humphreys 1995: xiii)

WHAT IS KNOWN ABOUT THE KIMBERLEY KARST?

Some early cave recordings include

- Wangahinnya Cave near Barnett Spring by Basedow (1918)
- The Tunnel in the Napier Ranges by Jack (1906).

Other early explorers visited caves. Woodward observed in 1907 (as cited by WASG 1973) that the Napier Range is *"riddled by numerous caves, some of which are of very considerable dimensions, but strange to say they are almost destitute of stalactites, and when these do occur, they are of a dull grey colour"* (1973:228). Hardman wrote in 1884 about the Oscar Ranges, whilst undertaking research on the Kimberley geology. It was recorded that he stated that *"fine clear crystals of Iceland spar (calcite) occur in cavities in the limestone, as also small deposits of gypsum.*

In the limestones of the Geikie Canyon calcspar is plentiful so also are stalactites and stalagmites, in caves or coating the exterior of the rocks". (1973:228). Hardman also wrote about the Mt Pierre area, saying *"large caverns with stalactites are found in the hills (of carboniferous limestone) near Alexander Creek, and at Mt Pierre".* (1973:228). He described several interesting caves, with large stalactites forming pillars and descending from the roof in icicle – like forms. The authors found that these early recordings of caves within the Kimberley region made interesting reading.

Table 1: The Karst areas of the Kimberley, as outlined by Bridge (1973) & Jolly & Lance (1980) and according to the ASF "Karst Index".

Area Prefix	Range Name	Location
KN	Napier Range	E Derby – 90 km – between Alexander Crk and 5km S of Carpenter's gap
KH	Horsespring Range Hull Range	E Fitzroy Crossing
KP	Pillara Range	East Fitzroy Crossing
KG	Geiki Range	E Fitzroy Crossing
KO	Oscar Range	NW Fitzroy Crossing
KL	Lawford & Laidlaw Range	SSW Fitzroy Crossing
KNI	Ningbing Range	N of Kununnurra
KJ	Jeremiah Range	N of Kununnurra

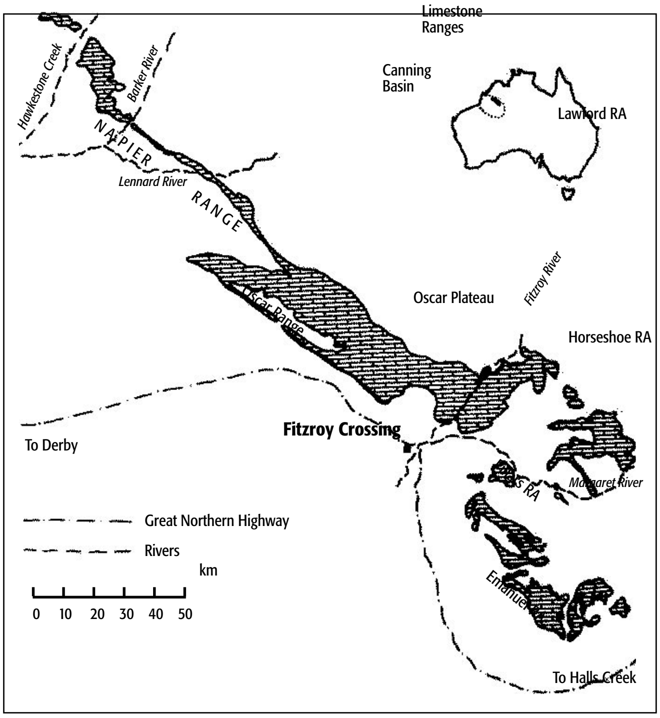

Figure 1: Map of Karst Areas in the Kimberley (after Nicoll 1977)

It is understood that Lex Bastian visited the area around 1973 (Bastian 1973).

In 1978, WASG published the "WA Nomenclature list No. 12" (Bridge 1973). This was the first documented speleological record of Kimberley karst features that the authors have found. At that time it was clearly stated that *"it is not intended to number the Kimberley caves until some years in the future when a great deal more is known about their distribution"* (1973:225). There was a list of about 35 karst features and references to their documentation. Table 1 lists the karst areas, their prefix and location. Cave area locations are shown in Figure 1.

EXPEDITION FIELD RECORDS

It is clear that the aim of speleological trips is to document karst features, particularly caves. How well this occurs depends on the particular skills and interests of those involved. It is clear from the reading of many volumes of speleological journals that the majority of documentation undertaken in the early years of speleo exploration was by speleologists whose profession was one of the sciences. It is appreciated that information may have been obtained from expeditions or field trips to the Kimberley under the auspices of groups other than speleological groups – the WA Geological Survey, State Government Departments or private individual trips.

The mechanisms for recording activities or documenting findings may be expected to be different from those of speleological groups.

Additionally, the motivation of individuals on recreational trips – say for a university group, would be different from those of a speleological group. It seems that many papers were written where extensive amounts of information were obtained, caves mapped etc, over a number of trips. In many situations, each individual trip is not specifically documented – but the outcomes of the trips are – for example a map is produced – but it has not been recorded who was on the trip, where they went, what exactly they found or looked at and on what dates they did it!

It would appear then, that there are no "official" WA trips, or organized speleological expeditions documented clearly in the literature.

The papers that have been written indicate that trips occurred during the time when a large amount of papers and articles were being written regarding the area. Clearly this is not an accurate reflection of WA speleological activity at the time.

Thus, it is the authors' belief that a systematic approach was not taken by the WA Speleological Group, and that a large amount of important information on the area rests with a number of individuals and groups.

It is obvious from a reading of Kimberley related documentation on these expeditions/field trips that there was a strong focus on the area's geology, geomorphology and speleogenesis.

There was some speleo interest in bats, as species were identified on a cave-by-cave basis, but there was little documentation of invertebrate fauna. So it appears that the main aims of a speleo expedition 35 years ago involved surveys and cave descriptions. However, for other groups, visits to the Kimberley were purely "tourist" trips and they visited caves already found by others.

The authors find that the main aims of recent WA speleo expeditions has been to document as much information as possible about the caves and karst system as a whole. For example, the following needs to be considered when documenting a karst area: the karst values, the area's significance, the karst features, biology, archaeology, palaeontology, hydrology, surveying and documenting caves as well as the collection of subterranean fauna for the WA Museum.

HISTORY OF DISCOVERIES

The early explorers found the *"caves are to be found in practically all areas where creeks run out of, or into, the range. Most entrances…characterized by trees or vines at the mouth"* (Cox and Dohnt 1971:78). Explorers marked the discovery of a cave by an "x" cut into trees. It was noted that the walls of the gorge (Windjana Gorge) were honeycombed with caves and the limestone cliffs had numerous holes at all elevations. Some explorers left these areas alone, due to a lack of time or equipment, while other explorers noted what they saw. It is also interesting to note that when surveying a cave, some explorers examine every accessible hole and survey all of the cave passages, while others focus only on obvious passages. Lowry (1967) stated *"during surveying, any passages that required more than a yard or two of crawling or chimneying were abandoned in favour of passages where progress was faster"* (1967:68). The WASG discoveries of the Napier Range have involved explorers walking the range face and the surface of the range – techniques similar to those used by the early explorers – but a difficult task in grike country. With the introduction of GPS, the recording of locations of caves and karst features has become much more accurate.

Lowry visited the area in mid 1962 and 1963 (Lowry 1967). He spoke about the "cave springs" at Lawford Range – *"these accounts are inadequate as the authors did not record the existence of the extensive network of passages"* (1967:62). In regard to KL6, he stated that the cave is several hundred metres long but the unpublished survey conducted by the 1979 ISS trip shows only about 150 metres (Jolly & Lance 1980).[1]

Some of the authors' concerns in trying to gather information into one central place, to enable systematic karst study in the future, is the lack of information available on karst features that were documented in the 1960's and 1970's. For example, the WA Karst Index Database co-ordinator has a number of ISS maps, however as there was no location information provided, these maps have very little value. Particularly when the majority of caves have not been tagged for future reference. Thus, there is the potential situation where caves are re-discovered and re-surveyed without knowledge that a particular cave has been recorded already.

USEFUL TECHNIQUES

A common problem for cavers is how to relocate a cave that was found in the past. Thus, initial explorations and documents regarding karst areas need to detail cave locations in a way that makes their "re-location" possible. Otherwise – caves will be "found" several times and cavers spend countless hours documenting something that has already been discovered and documented. This information need not ALL be in a trip report – it could be with the description of the cave as specific cave identification or location information. It is however, important that trip reports document the activities of groups or individuals – not only with regard to what they found – but also where they were/went prior to and after finding it!

It is very useful for example, to know whether a ridge was searched by a party of four spread out individuals or whether one caver walked one side of the ridge. Another example is how far along a cliff face or range the group walked searching for caves. The situation we have in the west Kimberley is how much of the face of the Napier range has been examined – it may only be several kilometers, it may be the whole length. Has the northern side of the range been examined for karst features? What about from the top of the range – how much exploration has occurred and where has it occurred?

Early techniques included describing a feature and its location in relation to a nearby well-known feature. For example, the direction and number of miles from a spring or river was given.

A cave may be marked *"with an x facing west cut into a tree"* (Cox & Dohnt 1971:76). This then progressed to locating karst features on a topographical map. Depending on the scale of the map this may or may not be helpful to future visitors to that area. In this technique, a grid reference number was given and a specific topographic map referred to (Bastian 1973).

The introduction of the ASF cave and karst numbering and naming system gave explorers some guidance on field expeditions. Cave entrances could be tagged and descriptions of caves and karst features followed a standard set of criteria. The descriptions of locations of tags in a cave entrance enable accurate identification of caves and karst features.

The authors have found however, that locating a tag in an obvious and visible place is essential. On occasions the authors have only seen the tag on exiting the cave (it has been recommended that it should not be visible from the daylight/entry of the cave), which can be problematic if a group finds a cave – thinking it is new – surveys the cave and then discovers a tag later.

Robinson (2004, pers. comm.) has stated that techniques on their expeditions in the early years involved making a cairn in the cave and placing a stainless steel plate (club tag) on the cairn. The authors' concern is that these temporary structures may be eroded or washed away over time.

The introduction of the GPS and the removal of selective availability has meant that cave locations can be recorded much more accurately.

However, due to the nature of the terrain and limitations of accuracy, it is still extremely useful to have detailed descriptions of caves and cave locations clearly documented.

One useful technique is to have small area maps – if there are a number of caves in an area where it is hard to describe all of their locations. The researchers should draw a small diagram and specify where the caves are in relation to each other.

With the introduction of aerial photographs, these were also used in conjunction with topographical maps to locate areas of high cave potential. Recent WASG expeditions have utilized digital aerial images and electronic topographical maps. These allow more accurate positioning of karst features and the identification of parts of the range.

The current field techniques include the group/several individuals carrying a GPS so that it "tracks" the groups/individual's total route over an area. This is later downloaded into a computer and it can be documented where the karst area has been searched. This information is useful, in that explorers will know which areas have already been thoroughly examined.

Surveying techniques have moved from the simple compass and tape to the use of a compass, clino and tape. The instruments used will determine the grade of the survey. WASG expeditions have documented in great detail the interior of caves. This takes a large amount of time and means that there is a large amount of information on the maps/cave.

More recent trips have changed the focus of surveying from explicit detail to significant detail. It is acknowledged that the members of expeditions are in an area for a limited

1. A survey of KL:6 was published (see *ISS Newsletter* 2(1):13) and it shows about 1200 feet (approximately 360 m) of passage. A much improved map was then published in 1980 which shows 320 m of passage but the cave looks quite different. Much more significant was the work in Mimbi (Cave Spring) Cave where over 850 m of passage was surveyed. (*ISS Nl.*, 2(3):14) (Eds.).

time and there is a need to obtain as much information as possible without spending the whole trip focusing on only one cave. WASG expeditions now utilize an electronic measuring device called a “disto”. This laser-measuring device removes the need for two people using a traditional “tape”.

It is both time saving and has minimum impact on the cave. The surveying team can “point and shoot” and obtain highly accurate distances without having to physically explore the whole cave in detail.

FUTURE GOALS AND TECHNIQUES

Topographic maps can be printed (in colour or black/white) to allow groups to have small and detailed maps with them in the field. This is primarily to assist explorers in surface navigation – due to the fissured karst topography – traversing the karst area like Napier Range can be disorienting.

The authors would like to encourage the use of hand held “palm” or computer technology in cave surveying and recording. This would allow data to be recorded electronically on site, rather than manually recording and later entering data into a computer back at camp. This would then be entered into a Geographic information system (GIS). Currently, we are investigating the implementation of GIS.

Other goals include further documentation of the areas’ biology, particularly, the bats of the area. Many different types of bats have been observed. There is an opportunity for further research in this area.

Additionally, the authors would like to document the caves in the area that were traditionally used by local Aboriginal groups. The WA Geological Survey has several maps that list significant caves sites in the area of which the ASF was not aware. These caves do not appear to be on the current Kimberley karst list.

The authors note that within the whole karst system there are numerous significant indigenous sites containing artifacts and rock art. Some of these sites are “fenced off’ or protected in some other manner. Speleological expeditions document new caves and karst features that may be culturally significant but which either do not appear to be known to local communities or may not yet have been protected. In 2004, the WASG expedition located several new karst features with significant hand paintings. Thus there are significant cultural sites in the karst area.

KIMBERLEY KARST – MANAGEMENT AND PROTECTION

There are a number of discrete karst systems in the Kimberley Region (generally termed the West Kimberley or the East Kimberley) that have no formal karst management. In the east, the primary form of land tenure is pastoral leases and station land. In the West, there are some National Parks, and other areas of pastoral lease and private land. All of these areas need appropriate karst management, in particular a “total catchment management” focus (Watson et al. 1997). There have been a number of expeditions to this area over the last 45 years, however a lot more extensive work is required to document the fauna and the karst.

It has recently come to the authors’ attention that there was a review of nature conservation reserves in the Kimberley in 1991. Humphreys (1995) outlines some of the recommendations that were made for the karst areas of the Kimberley, and refers to a submission made by the ASF in 1980. The caves and karst of the West Kimberley are considered to be of considerable international significance. The area’s current land management regime does not adequately provide for the reservation and protection of important karst features, nor does it recognise outstanding opportunities to incorporate features into existing reserves that would considerably enhance their value. Point 1.8 of the ASF submission (Davey 1980) recommended that *“there be a thorough integrated survey of all the cave and karst features of the Limestone Ranges of the West Kimberley and that such a survey should examine geomorphological and biological attributes as well as aboriginal relicts”.* It is understood that it was recommended that the WA Museum be requested to make a survey of the caves and springs for the limestone ranges.

Humphreys (1995) indicates that this survey has never been conducted. It is our recommendation that the current status of the karst areas in the Kimberley needs upgrading and that the National Heritage List may be an appropriate mechanism for recognising the “outstanding” values of the area (Anderson, in prep. b).

CONCLUSION

As discussed in this paper, the karst of the Kimberley is extensive. This significant karst system needs to be accurately documented and recorded. This will allow future speleological expeditions to focus on exploring new areas and recording significant information. The Kimberley karst area also needs further protection. Currently a large proportion of the karst is in “rangelands” and pastoral leases. A reserve system would be more appropriate and is something that needs further consideration. The Kimberley karst needs to be acknowledged for its significant karst values and requires appropriate karst management. It would be excellent if the WA Government and speleological groups could work together in this regard. ■

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POSTER

AN UPDATE ON THE EXPLORATION OF THE NULLARBOR KARST

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ABSTRACT

A detailed description was given at the last Conference of exploration up to and including the collecting of megafauna bones from three caves in May 2002. The W.A. Museum continues to work on these.

Two post-Easter trips in 2003 and 2004 have yielded a further 194 and 603 features respectively. Many features located from the air remain to be documented on the ground.

Those visited so far include several respectable caves, one of which is a smaller version of Thampanna doline and entrance named 'Whispering Cavern'. Features are seen to be somewhat clustered, and other areas are all but devoid of any. The significance of the data remains to be understood. The documentation process is outlined.

Exploration is ongoing, typically some 1500 sq. km per year. The focus continues to be on all karst related features rather than just caves.

POSTER AND INTERACTIVE WORKSHOP

IS IT A CAVE AND HOW LONG IS IT?

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REVIEW OF THE WORKSHOP

The purpose of this presentation was NOT to present dogmatic or erudite definitions of the subject, nor to exhaustively review and discuss the subject. Instead, enlarged poster copies of Sheets 1 and 2 were displayed prior to the Workshop, participants were invited to apply their experience and perceptions to a variety of actual cave maps, and key concepts and issues were then discussed in workshop.

Many speleologists have little familiarity with caves in tropical Australia, so differences between caves in temperate and tropical environments were highlighted, with particular attention given to caves in the tropics, many of which are characterised by roof holes, collapses, grikes and multiple entrances to a far greater extent than is encountered in temperate latitudes. Discussion then proceeded on segmentation of cave passages, roof holes and collapses, large chambers, dolines and shafts, drip lines etc. The definitions presented at the conclusion were those employed in surveying Bullita Cave in the Northern Territory.

Workshop discussion raised some interesting points relating to recent advances in the technology of cave surveying whereby cave passages visible to the surveyor can be measured without human entry. Thus in Lechuguilla Cave (New Mexico) electronic distance measuring devices (DISTO) are now measuring the length of some passages large enough to traverse, but considered too fragile to enter. The even more recent development of the spinning IR laser (Anon. 2004) similarly raises the prospect of rapid electronic surveys of cave passages with quite limited human entry, indeed of decisions about lengths being determined only after a 3D map is automatically generated post-survey.

Consistent application of the principles covered in the Workshop will very likely increase the length of any one cave even without discovery of significant new passage, and certainly as more accurate surveys are undertaken.

IS IT A CAVE?

From time to time debate takes place about exactly what *is* a cave and how to measure its length, and efforts are made to provide more rigorous definitions. So, the first question in our exercise is, is it a cave? (See Sheet 1). The ASF definition of "A natural cavity in rock, large enough to be entered by man" is probably the most useful general wording. Some definitions are enshrined in legislation. For example, in the USA the *Federal Cave Resources Protection Act 1988* defines a cave as "any naturally occurring void, cavity, recess, or system of interconnected passages which occurs beneath the surface of the earth or within a cliff or ledge (including any cave resource therein, but not including any vug, mine, tunnel, aqueduct, or other manmade excavation) and which is large enough to permit an individual to enter, whether or not the entrance is naturally formed or manmade. Such term shall include any natural pit, sinkhole, or other feature which is an extension of the entrance".

This is a start but leaves open debate about how long the "naturally occurring void" has to be in order to qualify, and it is here that perceptual differences arise. Refined definitions usually attempt a distinction between caves and overhangs or rock shelters, and/or set precise minimum lengths, but in reality there is a continuum involving ratios of height, width and depth, and total length and/or depth. At an ASF Conference over 20 years ago Ken Grimes gave an informal but enlightening presentation on the definition of a (primarily horizontal) cave. The consensus among participants then was that if the maximum entrance diameter is greater than the length of the hole, then it is a 'rock shelter' and not a cave. A similar approach could be used to separate dolines from shafts i.e. an open depression or shaft has to be deeper than it is wide to qualify. When it comes to minimum qualifying length Savage River CC, for example, sets a criterion of either 10m deep or 10m long. At Jenolan Sydney University Speleological Society appears to have used the criterion of whether a human body would fit into the hole.

So, to a large degree we all have our own subjective idea of what a cave is. We know one when we see it, but we should still observe the accepted criteria.

ONE CAVE OR MULTIPLE CAVES?

Argument sometimes arises about whether a particular system should be regarded as one cave or many. For example, James et al. (1988) record debate about whether the caves on the two sides of the Grand Arch at Jenolan are part of the same system. In early lists (e.g. Ellis 1971) the two systems were listed separately and dissent from the consensus that there was really only one cave seemed to be based on daylight penetrating the entire arch, which in fact is more than 150m long between driplines. Minor collapses and daylight holes such as in Example 2 on Sheet 1 do not segment a cave and Example 8 is regarded as one cave because the openings are deeper than they are wide and it is possible to traverse the entire cave without passing outside the dripline. However example 7 is one cave only if the 3 larger collapses are deeper than they are wide. Crawford (1993) dealt with some of these conceptual aspects.

CAVE LENGTH

From here we move to the second question of how should we measure a cave's length and compare it with others (Sheet 2). Let's concede that because cave length is a simple number, people tend to grab hold of it and use it for comparative purposes, but it is a poor indicator of the true significance of a cave. From the point of view of a geologist or geomorphologist, the whole argument is fairly pointless. If a set of segmented passages is part of a genetic whole then it is one system, regardless of how many accidental collapses or discontinuities there are. For example, the main branch of the genetically part of the same system. And, even more than a map of a single cave, karst area maps showing the relative position of a series of such disconnected caves can enlighten understanding of the geomorphological processes at work. Surveyors should aim to do this regardless of any perceptions about whether there is one cave or multiple caves.

Several measures of length are available:

The *map length* (also called the plan length, horizontal length, or sometimes – misleadingly – as true horizontal length) is the corrected horizontal length shown on a plan i.e. the measured distance corrected for elevation or depression. This is a projection and underestimates the true length, especially in caves with significant depth. If this measure were utilised, for example, a 100m deep pothole would have a length of only a metre or two.

The *survey length* is the total of everything surveyed, including surface surveys, resurveys, surveys around large chambers, and splay shots, and is, for example, readily available on cave survey programs such as COMPASS. This is a useful statistic but even within a cave it over-estimates by double-counting sections of passages or chambers. James et al. recorded that over 8km of traverse was measured to survey the Grand Arch at Jenolan, but noted that the length of such a feature is the traverse line from dripline to dripline with projections to the passages leading from it.

The *cave length* is the sum of all the surveyed distances between the survey stations. It is defined as the measured slope distance (not the horizontal or vertical distance), including minor zig-zags, short tie-in shots, vertical drops and maze passages, but excluding splay shots, radial shots, circumference shots around large chambers. It is a measure also readily available on COMPASS and other programs.

Cave length has been the accepted statistic internationally for nearly 40 years (Kermode 1968) and may be regarded as the accepted measure for comparative purposes, while Chabert & Watson (1981) have already canvassed many of the resulting practical applications, especially mazes. Much of the reasoning behind this is based on a utilitarian argument. As we observed, cave length is a measure used primarily by recreational cavers, not scientists. It gives a good estimate of the true distance a caver has to travel to actually move through the cave, up and down over large breakdown, through difficult rock piles, and up or down vertical drops. Even then it probably underestimates the distance a little, for circuitous routes are often necessary to avoid floor pits and to traverse large breakdown piles.

This utilitarian principle effectively places a lower limit of about 30cm diameter on any cave passage, obviating any argument premised on the existence of proto-caves of dimensions too small to admit human passage, however significant those may be to scientific enquiry. However, passages still must be surveyed, and on current criteria must also have been entered. So cave passages, rifts, vertical shafts, phreatic tubes etc. which have not been surveyed are not counted in cave length, whether or not they have been entered. Bullita Cave, for example, has numerous narrow shafts up to 20m high, often reaching the surface through small daylight holes. Only the very few which have been climbed or descended and surveyed would be counted in cave length. Similarly, the Gunbarrel Aven at Wyanbene (NSW) is part of the length of the cave to the extent that it has been climbed and measured, but not to the height reached only by hydrogen balloons. Nor should the height of a chamber higher than it is wide be counted unless it has been climbed or descended and surveyed.

I have consciously not dealt in detail with cave depth, defined as the vertical difference between the highest and lowest survey points within a cave (not the vertical distance between the entrance and the highest or lowest surveyed point, unless the entrance is one of the vertical extremities). This is a much more precise measure than cave length, but again, domes, pits, rising shafts and rifts which have not been surveyed should not be included in cave depth.

Clearly there will always be an element of subjectivity about cave length. However, a caver consulted about this presentation observed that if there is a general consensus (either nationally or internationally) about acceptable ways to define a cave and measure its length, then different caves can be broadly compared using widely accepted criteria even if room remains for argument about precise definitions. That consensus does exist in the statistic of cave length.

In conclusion, I urge even experienced cave surveyors to consult the books now readily available on the subject, notably Ellis (1976) and Dasher (1994) to gain a wider understanding of conceptual and practical difficulties.

SOME WORKING DEFINITIONS (PRIMARILY FROM DASHER 1994)

The definition of a cave is not based on the existence of a dark zone, though that might be significant for biologists

"A cave is a continuous subterranean cavity; any discontinuity such as a collapse where one must leave and re-enter a cave, divides that cave into two caves"

"However, a daylight hole or collapse only segments a cave if it is not possible to travel between the two passages without crossing the drip line i.e. if the whole roof hole is not the full width of the passage."

"An open collapse pit is part of a cave (for purposes of adding to total length and/or depth, if and only if its greatest horizontal dimension (width, length or diagonal) is less than its depth"

ACKNOWLEDGMENTS

Ken Grimes, Chairman of the ASF Survey Standards Commission, offered useful advice about this presentation, along with Bob Kershaw, who has charge of protocols and standards for the survey of Bullita Cave, NT. The maps used to illustrate the presentation were from publications of Chillagoe Caving Club and from the Nullarbor Cave Atlas, CEGSA, 1986.

NOTE RE ACCOMPANYING WORKSHEETS

Note that in Sheet 1, the scale bars accompanying each map all represent a distance of 10m. ■

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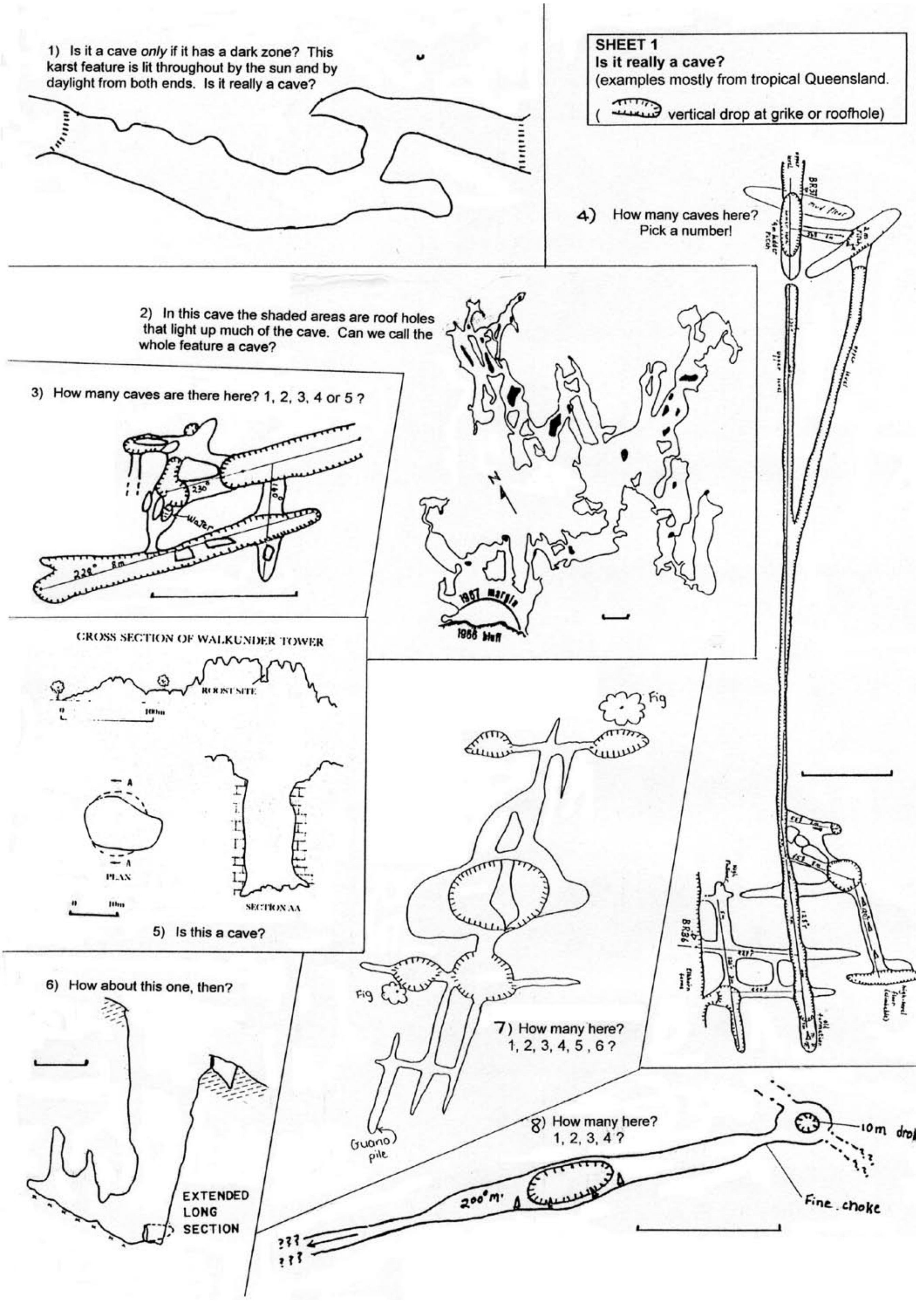
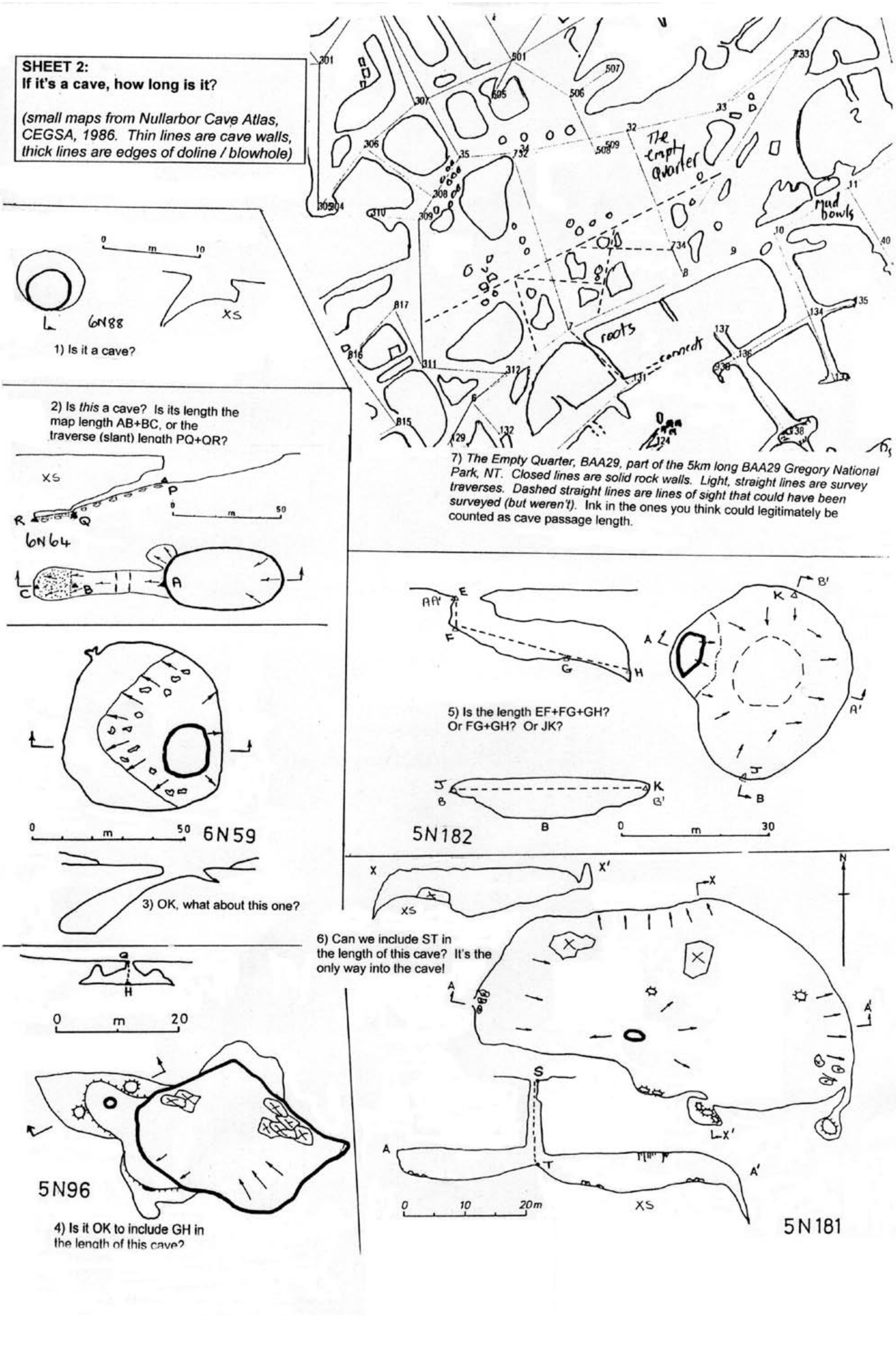

SHEET 1
Is it really a cave?
(examples mostly from tropical Queensland.
(vertical drop at grike or roofhole)
1) Is it a cave *only* if it has a dark zone? This karst feature is lit throughout by the sun and by daylight from both ends. Is it really a cave?
2) In this cave the shaded areas are roof holes that light up much of the cave. Can we call the whole feature a cave?
1957 margin
1966 bluff
3) How many caves are there here? 1, 2, 3, 4 or 5 ?
Water
230°
229°
8m
4) How many caves here? Pick a number!
BR31
BR36
CROSS SECTION OF WALKUNDER TOWER
ROOST SITE
100m
PLAN
SECTION AA
10m
5) Is this a cave?
6) How about this one, then?
EXTENDED LONG SECTION
Fig
Guano pile
7) How many here? 1, 2, 3, 4, 5, 6 ?
8) How many here? 1, 2, 3, 4 ?
10m drop
200m
Fine choke
???


SHEET 2:
If it's a cave, how long is it?
(small maps from Nullarbor Cave Atlas, CEGSA, 1986. Thin lines are cave walls, thick lines are edges of doline / blowhole)
6N88
XS
1) Is it a cave?
2) Is this a cave? Is its length the map length AB+BC, or the traverse (slant) length PQ+QR?
6N64
6N59
3) OK, what about this one?
5N96
4) Is it OK to include GH in the length of this cave?
7) The Empty Quarter, BAA29, part of the 5km long BAA29 Gregory National Park, NT. Closed lines are solid rock walls. Light, straight lines are survey traverses. Dashed straight lines are lines of sight that could have been surveyed (but weren't). Ink in the ones you think could legitimately be counted as cave passage length.
The empty quarter
Mud bowls
roots
connects
5) Is the length EF+FG+GH? Or FG+GH? Or JK?
5N182
6) Can we include ST in the length of this cave? It's the only way into the cave!
5N181

MADAGASCAR MYSTERY

- A DOCUMENTARY FILM FEATURING THE TSINGY DE BEMARAHA KARST OF WESTERN MADAGASCAR

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Overview of the the Tsingy de Bemaraha.

As principal cinematographer and director, Nicolas Gabriel explores the relationship between the surface and the subterranean ecosystems in this arid area of limestone pinnacle karst of western Madagascar. Acutely "eroded" by dissolution through the action of torrential downpours and strong winds during the very brief annual wet season, the karst landscape of the Tsingy de Bemaraha has a striking relief. Nicolas uses a mix of cleverly designed animated graphics to demonstrate the geological and geomorphic processes involved in the evolution of the karst landscape. Many new species of plants and animals are still being found on the surface and in the caves. Some of these new finds are shown in this film. In order to demonstrate the attributes of the Tsingy karst, Nicolas has engaged a team of international consultants: sound chaser and composer (Christian Holl), speleologist and guide (Jean-Claude Dobrilla), ethno-archaeologist (Monsieur Ramilisonina), botanist (Jean-Jacques Delavaux), herpetologist (Jasmin Randrianirina), entomologist and mammalian consultant (Andre Peyrieras) and cave biologist/ karst consultant (Arthur Clarke). The film has been sponsored by National Geographic who added the English commentary in this version produced for television audiences, including blanks for inserting commercial breaks.

Since being produced late last year, the film has won six awards at international film festivals:

- Sunny Side, France: *Prix Voyage Découverte* (Travel and Discovery prize);
- *Festival International d'Autrans du film Montagne Aventure, France: Prix du Film Nature et Environnement* (Nature and Environment prize);
- *Festival du Film de Val d'Isère Grandeur Nature* (Environment Film Festival), *France: Grand prix du Jury, Grand prix du public;*
- *Festival International du Film Alpin et de l'Environnement les Diablerets* (Switzerland): *Prix Spécial du Jury;*
- *Festival International du Film d'Aventure de Montréal* (Quebec): *Mention du Jury;* and
- *Festival Vertical du Film de Moscou* (Russia): *Primé.*

EARLY MAPS OF TUGLOW CAVES - THE BRACEWELL COLLECTION

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INTRODUCTION

The first half of the twentieth century is generally regarded as a time of few recreational visitors and little progress in the exploration, recording and management of our cave resources. It was a period of Australia's history not noted for encouraging innovation, scientific endeavour and curiosity. Some cave guides, of course, intermittently did some exploration but little was recorded. However, bushwalkers often gravitated to caving, indeed that is the origin of several speleological societies, but there were no such societies until 1946. Although some individuals made only a few trips, and there are few reports extant, a few did produce reports and maps which are of value if only because of their rarity. They fill in the social history of outdoor recreation in Australia.

HISTORICAL DATA

The SUSS Tuglow book (Cooper et al., 1998) revealed a lot of unreported history of the cave, but omits the maps prepared in 1939 and 1940, on a trip led by Ronald Bracewell, and earlier ones dating back to 1934. I tracked down Bracewell in retirement in California. He says of his previously unreported expedition that others present were his father Cecil Charles Bracewell, Horace A. Salmon, Hilary Jackson (Vice-President of the Trampers Club), George Loder (Trampers Club) and an Argentinian whose name he has forgotten. They built a rope ladder about 100 feet long using rungs cut on the spot. They saw Bouchier's name in pencil and an 1800s date. Salmon tried taking photographs using magnesium powder but his shutter jammed at the bottom. The maps were produced some months later and one (not reproduced) is labelled "Drawn from Memory by H. A. Salmon 20/11/39".

Bracewell says that this was his first and only caving trip, but that Salmon was the driving force behind the trip. Bracewell held on to the maps and some other minor papers for sixty years, donating them during a visit to Australia in 2000. On the other hand, Harper and Salmon had been actively caving for some years and the collection includes their five unrecorded but remarkably detailed maps dating back to 1934 but presumably taken on the later Bracewell trip. For their time they are good maps. Two show the same cross-section of the cave (though evidently on a different projection) as the Glanfield map produced by Cooper et al. (op. cit., p. 26) and attributed as possibly the first map of Tuglow Cave. At Easter 1934, Glanfield reached only the 135ft level, but Harper and Salmon obviously reached and mapped the river at 200ft.

The streamway in Tuglow Cave.

There must have been some discussion in bushwalking circles at the time about the rediscovery of the cave, and the inference is that Harper and Salmon heard about the Glanfield expedition, relocated the cave and this time reached the bottom. Harper's autobiographical papers (not examined for this paper, but cited by Cooper et al. as being in the possession of Prof. R Horne in Melbourne) may reveal exactly when the Harper trip took place. Word certainly got around: Cooper mentions two more trips reported in January 1935 by Oliver Moriarty which also reached the river and probably made further discoveries.

There are some fine cross-sections of the vertical elements. However, I am not familiar with Tuglow Caves so have had difficulty comparing these maps with those in Cooper et al. because the projections are to cardinal compass points whereas the SUSS map (2T1.SUS3) is oriented 240 – 60 TN. One map labelled "Phantom Plan of System" (Figure 5), is particularly difficult to orient with respect to the entrance, Knights Knobbly Knob Chamber and Tricketts Passage.

Bracewell, Giovanelli and Harper all joined CSIRO after graduation and remained lifelong friends. Ron Bracewell, BSc, BE, ME (Sydney), PhD (Cambridge), designed microwave radar in World War 2, joined the faculty at Stanford University in 1955 and went on to become Professor Emeritus of Electrical Engineering. Ron Giovanni DSc (1915-1984) had earlier been one of the authors of the well-known map of Colong Caves dated 1945 but originating in the 1930s. He became Chief of the Division of Physics in CSIRO and later coordinated the changeover from imperial to metric units on various dates over 30 years ago. Arthur Harper AO led the

Heat and Temperature Measurement Division of Physics for over 30 years and was Executive Member of the Metric Conversion Board, for example changing road signs overnight to a predetermined schedule. He died in 1991 aged 78. Described as the driving force behind the trip, Horace Salmon was a drapery salesman, founder and President of the Trampers Club and a bushwalking friend of Paddy Pallin.

Part of the collection, the maps reproduced here, are those drawn by Harper and Salmon. Despite the fact that he made only that one trip, Bracewell's collection and recollections provide useful additional insight into the beginnings of organised recreational caving in this country.

ACKNOWLEDGMENT

I thank Emeritus Professor Ronald Bracewell for permission to publish these data. ■

THE ORIGINAL MAPS

Tuglow Caves: sketch of 60 ft level, drawn from memory by H. A. Salmon on 20/11/39. Scale 1" = 20 ft. *(not reproduced here).*

Gangerang Range: hand drawn map signed by Ron Bracewell on 15th March, 1941 *(not reproduced).*

Tuglow Caves: Drawn from data collected in the Horse Gully Caves on 25-27 December 1939 and Tuglow Caves on 24-28 December 1939 and 28 January 1940 by R N Bracewell (5 sheets) *(not reproduced here, this is a cover sheet prefacing the next five maps).*

Tuglow Caves: Three sheets, two signed by A. F. A. Harper and H. A. Salmon. Sheet 1: "Plan of 135' floor", Sheet 2: "Cross-section of Drop 135' … 200' approx. (looking east) (?), Sheet 3: "Plan of 200" floor". Dated 1934. *(See Figures 1, 2 and 3)*

Tuglow Caves: Two sheets "Section looking West" and "Section looking South" with "Phantom Plan of System", signed by A. F. A. Harper and H. A. Salmon on 22/9/1934. (*See Figures 4 and 5).*

Tuglow River Caves, schematic representation of relative positions of cave passages, scale 1:720, signed R.N.B. 31-1-40 *(not reproduced here).*

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Bracewell, R. N. 1939-1940: A ms. Collection of maps of Tuglow Caves produced or collected by Ron Bracewell when exploring these caves near Oberon, NSW. Manuscript Collection, State Library of NSW.

Cooper, I., Scott, M. and Vaughan-Taylor, K. 1998: *Tuglow Caves,* Sydney University Speleological Society, 65 pp.

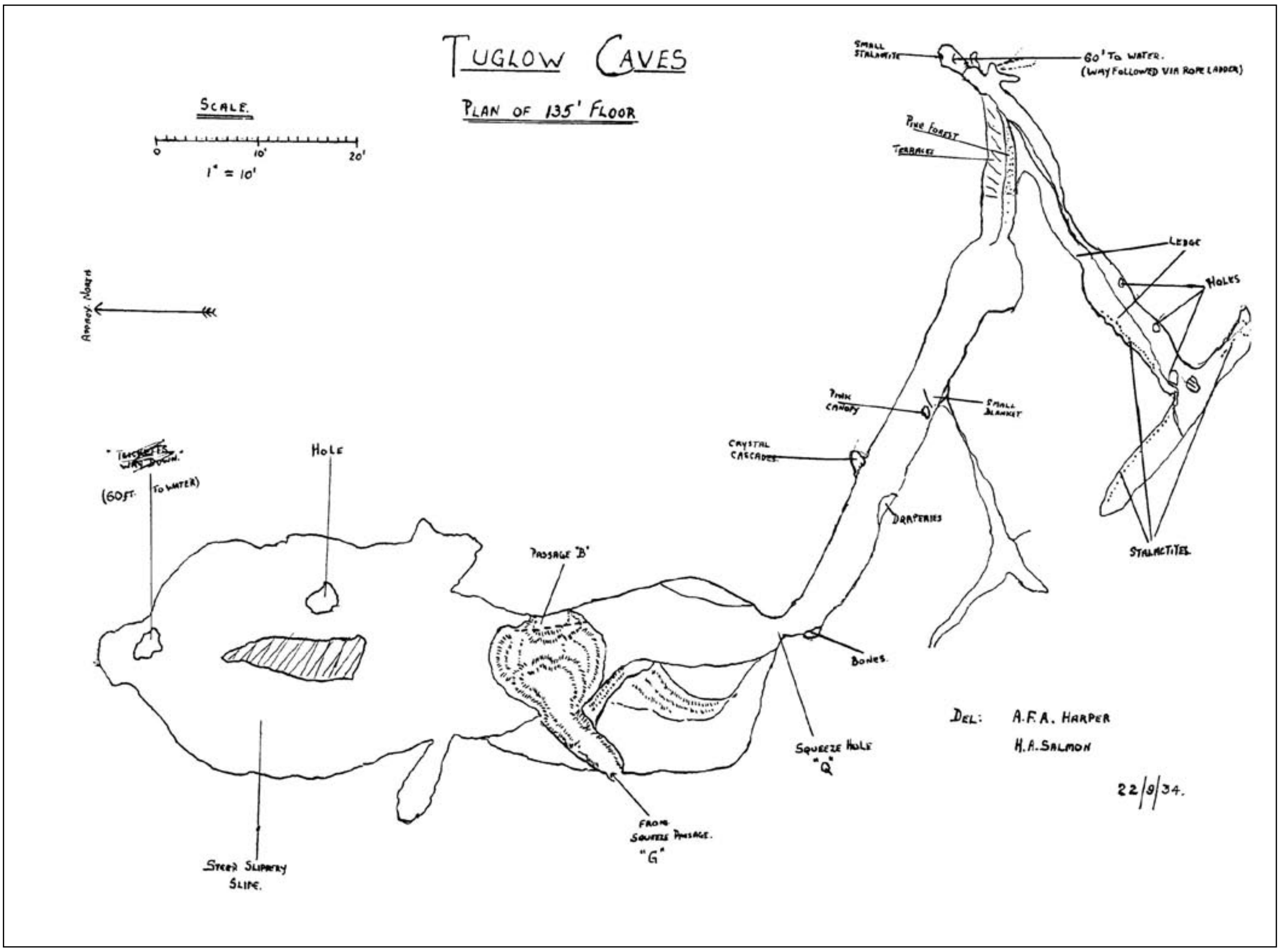


Figure 1: Tuglow Caves. Plan of 135' floor

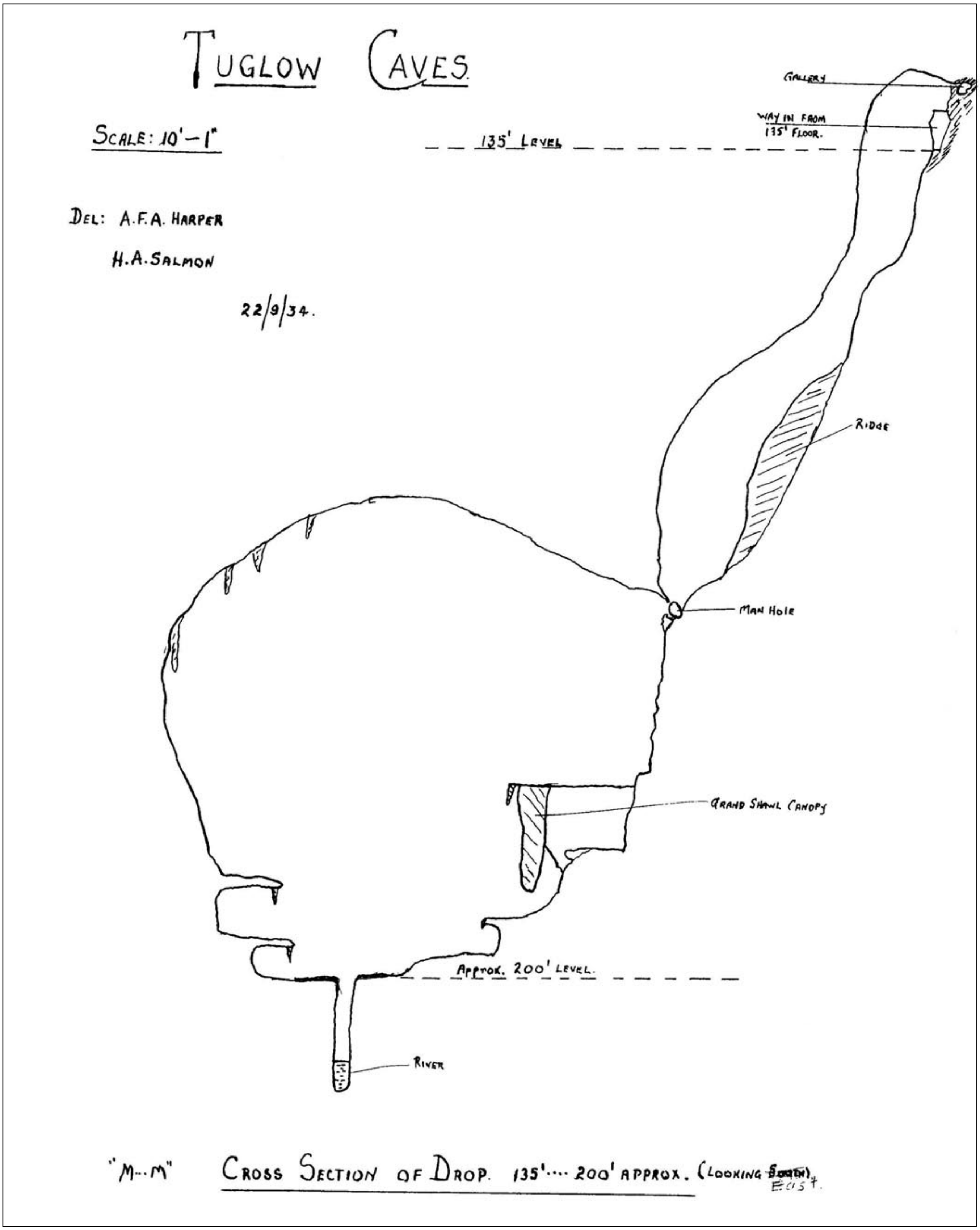


Figure 2: Tuglow Caves. Cross-section of Drop 135'…200' approx. (looking east).

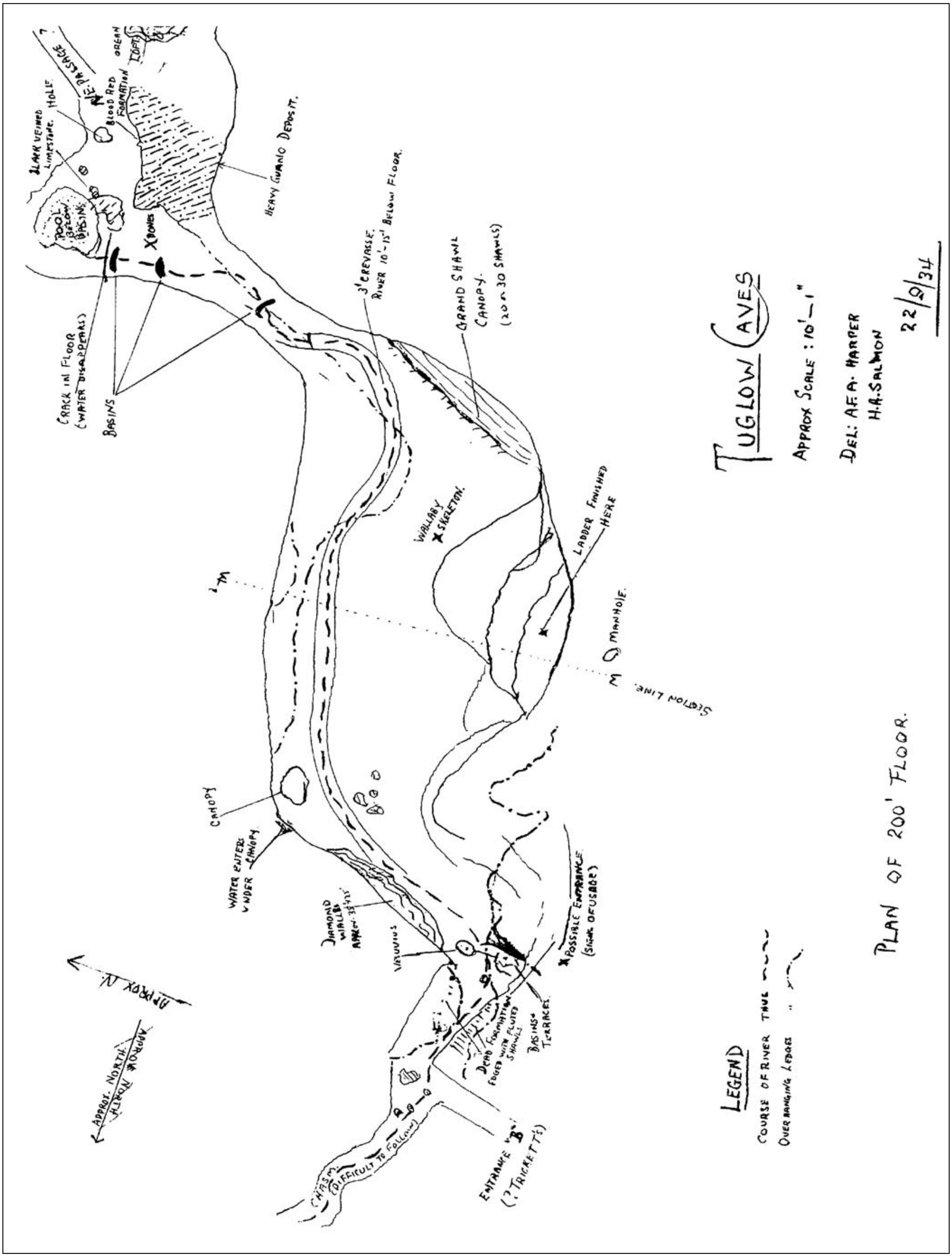


Figure 3: Tuglow Caves by A. F. A. Harper and H. A. Salmon (1934).

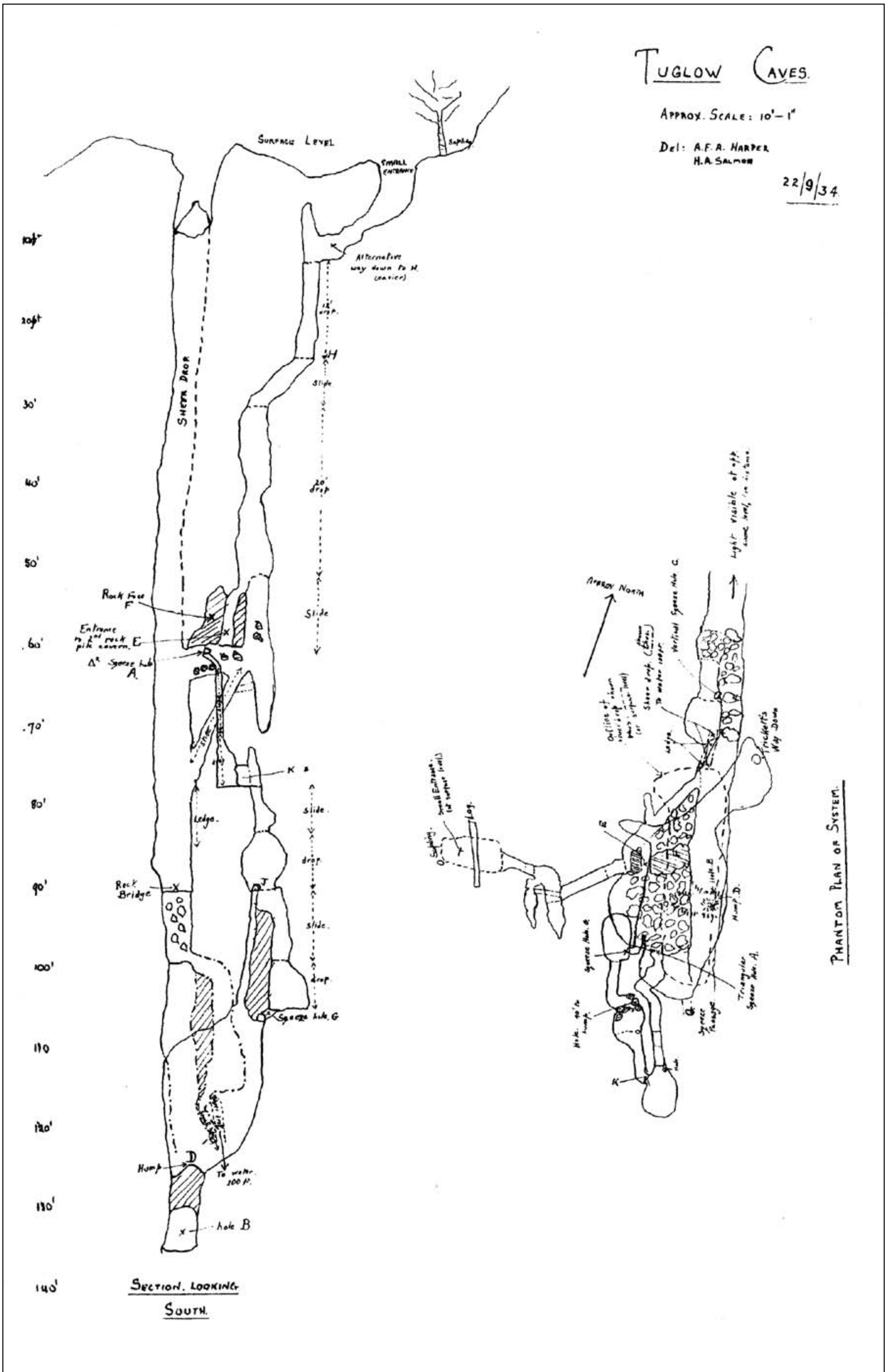


Figure 5: Tuglow Caves. Section looking South with Phantom Plan of System.

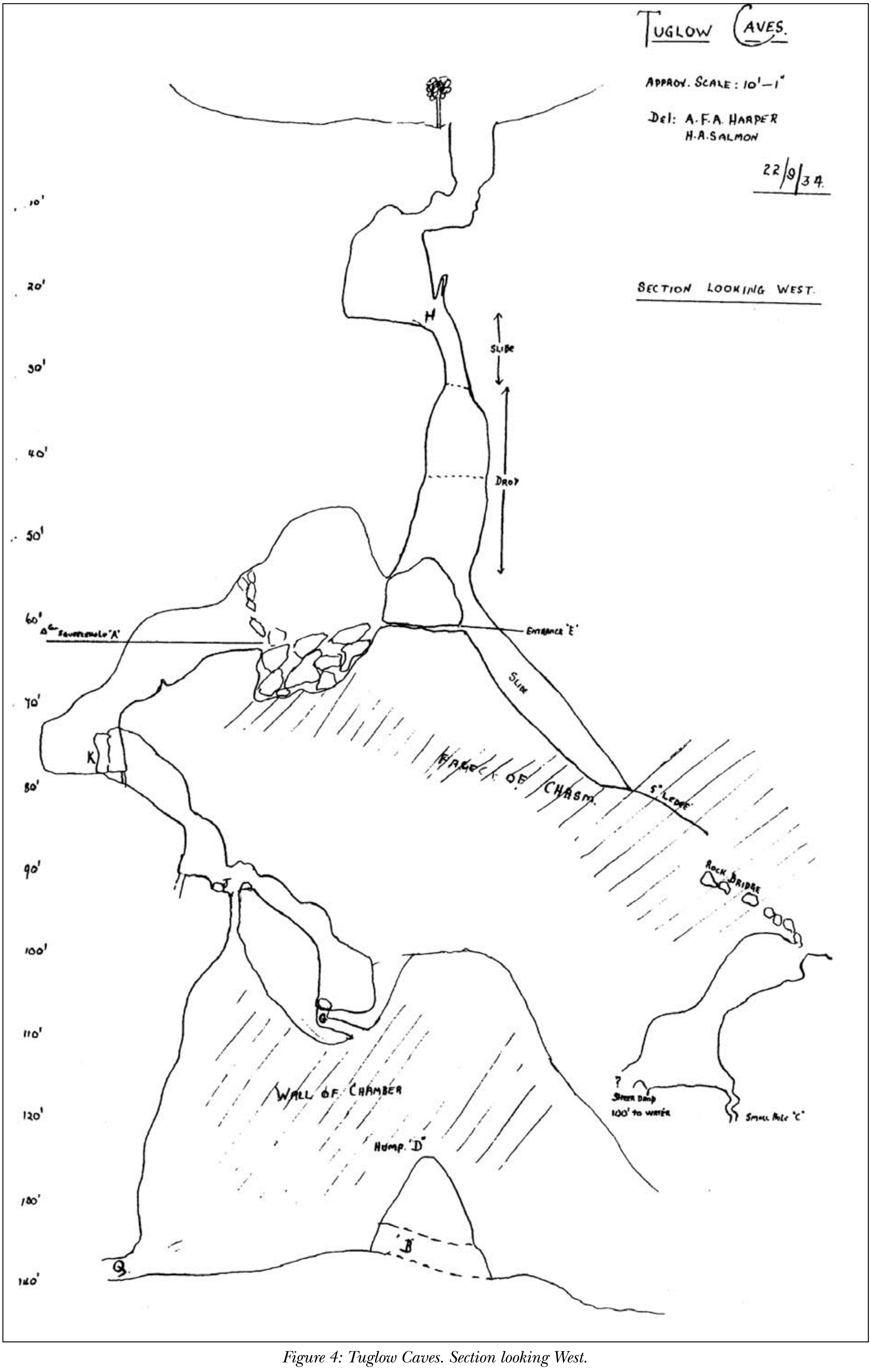


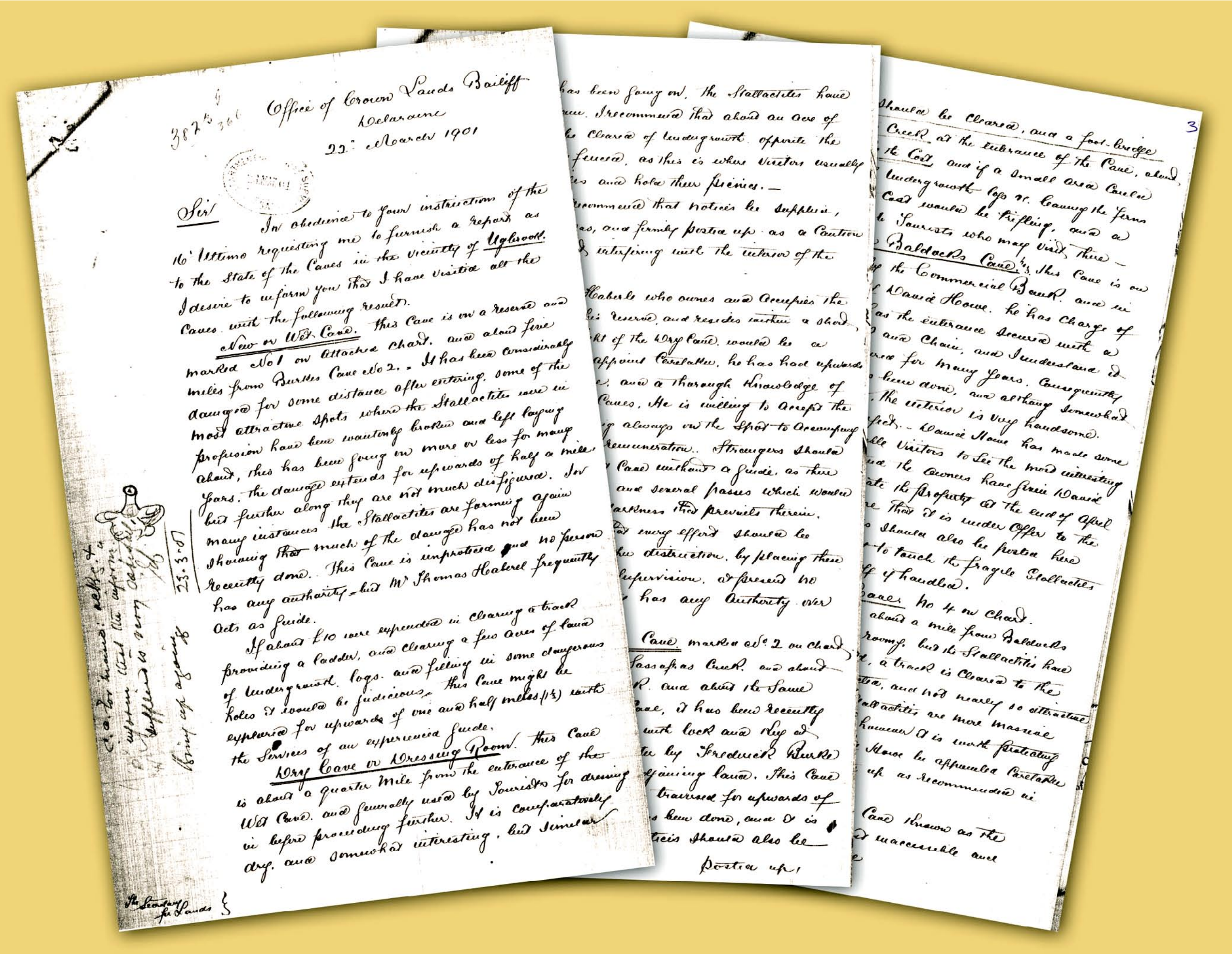
Figure 4: Tuglow Caves. Section looking West.

POSTER

"VERY INTERESTING, VERY BEAUTIFUL … AND FULL OF CURIOSITIES":

SOME HISTORICAL MATERIAL RELATING TO CAVES AT MOLE CREEK

Rolan Eberhard & Ian Houshold
Nature Conservation Branch, Department of Primary Industries, Water & Environment, GPO Box 44, Hobart, 7001


Office of Crown Lands Bailiff
Deloraine
22nd March 1901

Sir
In obedience to your instruction of the 16' Ultimo requesting me to furnish a report as to the State of the Caves in the vicinity of Uglwood. I desire to inform you that I have visited all the Caves with the following result.
New or Wet Cave. this Cave is on a reserve and marked No1 on attached chart. and about five miles from Burkes Cave No2. It has been considerably damaged for some distance after entering. some of the most attractive spots where the Stallactites were in profusion have been wantonly broken and left laying about, this has been going on more or less for many years. the damage extends for upwards of half a mile but further along they are not much disfigured. In many instances the Stallactites are forming again showing that much of the damage has not been recently done. This Cave is unprotected and no person has any authority - but Mr Thomas Haberl frequently acts as guide.
If about £10 were expended in clearing a track providing a ladder, and clearing a few acres of land of undergrowth logs. and filling in some dangerous holes it would be judicious. this Cave might be explored for upwards of one and half miles (1½) with the services of an experienced guide.
Dry Cave or Dressing Room. this Cave is about a quarter mile from the entrance of the Wet Cave. and generally used by Tourists for dressing in before proceeding further. It is comparatively dry. and somewhat interesting, but similar

ABSTRACT

Historical documents, recently come to light, add considerably to our knowledge of the history of caves at Mole Creek since first settlement. In 1879 surveyor Charles Smith wrote to the Minister of Lands and Works describing a richly decorated cave shown to him near Sassafras Creek. Smith contrasted the pristine state of the new cave with the degradation that had occurred at other Mole Creek caves, recommending that the land should be set aside as a cave reserve. This evidently provided the stimulus for one of three cave reserves created at Mole Creek in the 19th century, encompassing a total of 426 acres. However, by the mid 20th century, the largest of the cave reserves (300 acres) had been sold off, except for about 5 acres surrounding the most downstream entrance to Sassafras Cave, leaving most of the cave under private land. In 1901 the Crown Lands Bailiff reported on the condition of the caves, indicating that some of the caves at Sassafras Creek had been secured by gates and were in good condition. Those at Caveside (ie. Wet Cave and Honeycomb Cave) were unsecured and showed considerable damage. Despite early recognition of the need to protect the caves at Mole Creek, some caves suffered much damage within the first few decades of their discovery by Europeans. Where the colonial government did act to create cave reserves, the reserve boundaries rarely encompassed the underground extent of the caves, creating the situation that currently exists at Mole Creek whereby some of the most important caves are located partly in reserves and partly in private land or State forest.

INTRODUCTION

Details concerning early cave discoveries at Mole Creek, and European responses to these, are generally sketchy and sometimes subject to conflicting accounts. Some correspondence recently come to light adds to our knowledge in this regard. The material dates to the period 1879 to 1901 and is held on file at the Department of Primary Industries, Water & Environment in Hobart. At this time caves at Sassafras Creek were referred to as the "New Caves", whereas those near Caveside (Wet Cave and Honeycomb Cave) had been known since the 1820s and were called the "Old Caves" (Clarke 1999).

Transcript: Smith to O'Reilly 1879

Deloraine 20th August 1879
The Hon. C.O.Reilly
The Minister of Lands & Works

Sir

I have the honor to report that I have completed the Survey of Road from the Mole Creek to The Mersey River at the Site for Bridge in the Township of Liena and have succeeded in marking out a line of Road with easy Gradients through a large area of good Land which this Road will open up to Selectors, I hope to forward the Plan with detailed particulars in a week.

While making this Survey through the new Township of Ugbrook, I was informed by Mr. Willm Ried How, that he in company with his Son while looking for Timber he had discovered another Cave hid in thick Scrub, he had not made it known, fearing it might be despoiled, as the others had been, I went with him next day to see it, the shortest way, but over Rocky Limestone Hills impracticable for a Road.

I found the Cave in a perfect State of Preservation the Stalactites, and Stalagmites undisturbed, pure White and semi transparent, Clear as Alabaster assuming all sorts of fancyful Shapes, very Interesting, and very Beautiful.

The entrance to the Cave through an Aperture in the Face of Limestone Rock about 6ft x 3 ft and descends some 10ft to the bed of a small Stream, which at that time, the fourth of July, was about 6 Inches deep with Water, 9 or 10 feet wide, but Level, and Smoothe as a Gravel Walk, The Length at least as far as I could go then, Two to Three Hundred Feet, Height from 8 to 12 feet, and Width 10 to 20 ft and full of Curiosities, on one Side you may fancy a Sideboard covered with a heavy white Cloth and deep Fringe, with various ornaments placed thereon delicately White and Transparent with Hundreds of Stalactites at the Back like Clusters of Small Organ Pipes, also an Large one Suspended from the Top like a large [chased?] vase, or Chinese Lantern, and reaching down to about a foot of the bottom and when touched, Sounds as Sonorous as a Bell.

Considering the Cave in its present perfect state as Specialy Interesting I proceeded next day to find a practicable Road to it from The Township of Ugbrook, and also to ascertain its Locality.

Starting from an Old Ford across the Sassafras Creek and keeping on the Eastern Side I found an easy Level Road may be obtained to both Caves, and also to good Level Crown Land Lightly Timbered to the East, and South East, of the Caves, several Hundred Acres which will be immediately applied for, but may I request you not to approve of any, till the Road and Reserves for caves are finally disposed of, or we shall, as usual meet with opposition, and unnecessary expense in getting the best line for a Road, which will be required to open up this part of the district and connect it with Ugbrook and main line of Road.

I enclose a Chart showing the Localities and Distances.

Providing the new cave is not Reserved by the Govt or the Municipal Council, a few Gentleman here will subscribe to purchase the Cave and Sufficient Land around it, to Keep a Man on the spot, to Secure the Cave from spoilation, and keep it open to the Public in its pristine beauty, of course it requires Closing at once with Strong Doors, as a few Persons could destroy this Cave, as the others have been in a very short time.

If you will oblige me with your views, as early as possible whether you will make a Reserve around this Cave for the Govt, or the Municipal Council, I shall he happy in helping to secure it, as it is, to Public Service by Subscriptions, if it cannot be had without.

Waiting your further commands
I have the Honour to be Sir
Your most Obedt Sert
Chas J Smith

NOTES:

1. The principal cave described by Smith is that now known as Cyclops Cave. This is marked "W. How's New Cave" on a map held on the same file as Smith's letter (Figure 1). It is unclear whether this map is the chart referred to in Smith's letter, although it clearly depicts the same caves.
2. The cave marked "1st New Cave" on the map is Sassafras Cave – the principal source of Sassafras Creek except under dry conditions. This cave was discovered prior to 1868 when Sassafras Creek was shown rising from a cave on Walch's Map of Tasmania (Jones 1988, p. 238).
3. Smith's suggestion that he could raise a subscription to purchase the newly discovered cave was not taken up. His alternative – a government reserve – evidently stimulated the creation of a 37 acre Cave Reserve which appears on a land title survey of 1887(Figure 2). Some 99 acres at Wet Cave and 300 acres at Sassafras Cave (adjacent to the 37 acres) had already been identified for reservation, (see Figure 3) although Smith was evidently unaware of this when he wrote the report. In 1894 the two larger cave reserves were gazetted under the *Crown Lands Act 1890* (for some reason the 37 acre reserve was not included).
4. The boundary of the 37 acre reserve was evidently devised with reference to the estimated extent of the cave, which is shown as a dotted line on an 1887 title plan (Figure 2). In fact, the accessible passages in Cyclops Cave extend for a distance of little more than 100 m to the west of the cave entrance, not the 400 m implied by the old plan. No attempt appears to have been made to include all of Wet Cave in the 99 acre reserve at that site – possibly the land had already been granted.
5. Smith's recommendation that the cave should be protected by "Strong Doors" had been given effect by 1901 (see Berresford letter below). There is now no obvious sign of a gate at this site, which has been left open for many years.

Transcript: Berresford to Counsel 1901

Office of Crown Lands Bailiff
Deloraine
22 March 1901

Sir

In obedience to your instructions of the 16' Ultimo requesting me to furnish a report as to the State of the Caves in the vicinity of Ugbrook I desire to inform you that I have visited all the Caves with the following result.

New or Wet Cave. this Cave is on a reserve and marked No1 on Attached Chart and about five miles from Burkes Cave No.2. It has been considerably damaged for some distance after entering, some of the most attractive spots where the Stallactites were in profusion have been wantonly broken and left laying about, this has been going on more or less for many years, the damage extends for upwards of half a mile, but further along they are not much disfigured. In many instances the Stallactites are forming again showing that much of the damage has not been recently done. This Cave is unprotected and no person has any authority but Mr Thomas Haberle frequently acts as guide.

If about 10 pounds were expended in clearing a track providing a ladder, and clearing a few acres of land of undergrowth, logs, and filling in some dangerous holes it would be judicious. This Cave might be explored for upwards of one and half miles (11/2) under the Services of an experienced guide.

Dry Cave or Dressing Room. This Cave is about a quarter mile from the enterance of the Wet Cave and generally used by Tourists for dressing in before proceeding further. It is comparatively dry and somewhat interesting, but similar destruction has been going on. The Stallactites have not formed again. I recommend that about an acre of land should be cleared of undergrowth opposite the enterance, and fenced as this is where visitors usually keep their vehicles and hold their picnics.

I strongly recommend that notices be supplied, printed on Canvas, and firmly posted up as a Caution to visitors against interfering with the interior of the Caves.

Mr Thomas Haberle who owns and occupies the land adjoining the reserve, and resides within a short distance, and in sight of the Dry Cave, would be a desirable person to appoint Caretaker, he has upwards of 25 years experience, and a thorough knowledge of the interior of these Caves. He is willing to accept the appointment and being always on the spot to accompany visitors, for a small renumeration. Strangers should not venture in the Wet Cave without a guide, as there are dangerous spots, and several passes which would be impossible in the darkness that prevails therein.

I am of opinion that every effort should be made to prevent further destruction, by placing these Caves under further supervision, at present no person in the locality has any authority over them.

Little or Burks Cave. marked as No.2 on chart this is on the Reserve at Sassafras Creek, and about five miles from Mole Creek, and about the same distance from the Wet Cave, it has been recently secured by a strong gate with lock and key at enterance, and looked after by Frederick Burke who is the owner of the adjoining land. This Cave is very pretty and can be traversed for upwards of 300 yards, little damage has been done, and it is in fair preservation. Notices should also be posted up, a track should be cleared, and a foot-bridge put over the creek at the enterance of the Cave, about 2 pounds would be the cost, and if a small area could be cleared of undergrowth logs [?] leaving the ferns and trees, the cost would be trifling, and a convenience to tourists who may visit there.

Bolar or Baldocks Cave. no.3 this cave is on land owned by the Commercial Bank and in the occupation of David Howe. He has charge of this cave, and has the enterance secured with a strong gate, lock and chain, and I understand it has been so secured for many years. Consequently little damage has been done, and although somewhat difficult to traverse, the interior is very handsome. The Stallactites perfect – David Howe has made some improvements to enable visitors to see the most interesting spots. I understand the owners have given David Howe notice to vacate the property at the end of April next. He informs me that it is under Offer to the Government. Notices should be posted here requesting visitors not to touch the fragile Stallacitites many would break off if handled.

Saw Mills Cave. no 4 on chart. This is on a reserve and about a mile from Baldocks Cave it is very large and roomy, but the Stallactites have been more or less destroyed, a track is cleared to the enterance, it is unprotected, and not nearly as attractive as the other Caves. The Stallactites are more massive and not so handsome, however it is worth protecting and I suggest that David Howe be appointed caretaker and guide. Notices posted up as recommended in other Caves.

There is another Small cave known as the Rock Hole. no 5 which is almost inaccessible and not of much importance.

NOTES:

1. This letter lacks a signature block and is evidently incomplete. The chart showing cave locations mentioned in the letter has not been found. Other correspondence on the same file indicates that H. Berresford was the Crown Lands Bailiff at Deloraine at this time. He was writing to Counsel, the Secretary for Lands.

2. Berresford's "New or Wet Cave" matches the description of Wet Cave. However, reference to "New" contradicts evidence that the caves near Caveside were referred to as the "Old Caves" following the discovery of caves at Sassafras Creek (Clarke 1999). Berresford's letter suggests that by 1901 the distinction between old and new caves had become blurred. Alternatively, he may simply have got the names mixed up.

3. Berresford's cave names are mostly no longer in use. "Dry Cave or Dressing Room" matches the description of Honeycomb Cave, while "Little or Burkes Cave", "Bolar or Baldocks Cave" and "Saw Mills Cave" are probably Cyclops Cave, Baldocks Cave and Sassafras Cave respectively. "Rock Hole" could be one of several small caves in the vicinity of Sassafras Cave.

4. In 1901 the Crown purchased a 100 acre block which had been granted prior to the discovery on it of Baldocks Cave. Part of the land was declared a State Reserve in 1939 (see Figure 3).

CONCLUSION

By the late 19th century the colonial government recognised that newly discovered caves at Mole Creek were at risk from damage by visitors. This was accompanied by a level of official interest in protecting the caves, leading to the appointment of caretakers, installation of cave gates and the creation of cave reserves. By the 1890s, the Crown had set aside as cave reserves some 426 acres (~173 ha) of land at Mole Creek, encompassing Cyclops Cave, Sassafras Cave and parts of Wet Cave and Honeycomb Cave. The Crown purchased an additional 100 acres at Baldocks Cave in 1901, although this was not formally reserved until 1939, and then only in part. As in New South Wales (Hamilton-Smith 1998), some of Tasmania's earliest reserves were created to protect caves.

Despite initial interest in protecting the caves at Sassafras Creek, this was not sustained. An important factor in this was the discovery of more spectacular caves at Mayberry and Liena: Marakoopa Cave and King Solomons Cave. They were eventually acquired by the government and became major tourist attractions, as they are today. In a sad parody of the vandalism and neglect that had occurred at the "Old Caves" near Caveside, the “New Caves” at Sassafras Creek lost out when the cave tourism focus shifted further west again in the early decades of the 20th century.

By 1911 about two thirds of the 300 acre cave reserve at Sassafras Creek was excluded from a new reserve gazetted at this time, (see Figure 3) the balance being sold off to private interests. A miserable 5 acres of the original 300 was proclaimed a State Reserve in 1939, leaving most of Sassafras Cave and several other significant caves without protection (Figure 3). The new reserve was not provided with legal public access, being entirely surrounded by private land. In 1996 the three small State Reserves at Sassafras Creek were incorporated in the Mole Creek Karst National Park – a collection of mostly small pre-existing reserves and Crown land parcels. Although two caves at Sassafras Creek had been secured with gates by 1901, these were not maintained and much damage undoubtedly occurred after cave tours ceased at Baldocks Cave. In an ironic twist, the Tasmanian Government has recently negotiated to covenant or purchase a number of private land blocks in the Mole Creek area, in order to provide greater security for caves that the Crown had sold off in the 19th and 20th centuries ■.

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Hamilton-Smith, E. 1998: Changing assumptions underlying national park systems, in Hamilton-Smith, E. (ed.); *Celebrating the Parks: Symposium on Parks History,* Mt. Buffalo, Victoria, 16-19th April 1998.

Jones, A. 1988: *Convicts and Carriageways: Tasmanian Road Development Until 1880,* Historical Committee of the Department of Main Roads, Tasmania.

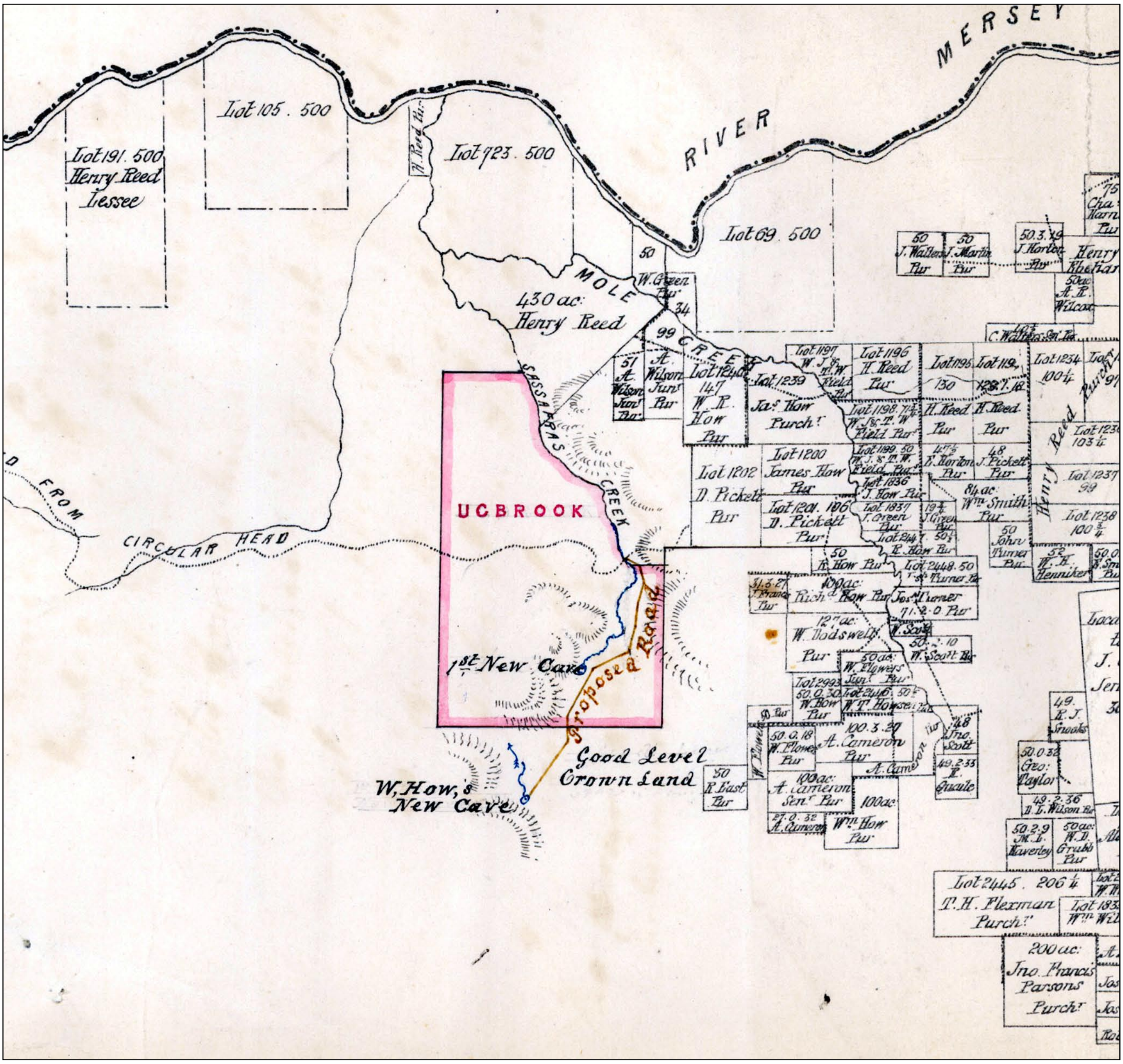

Figure 1: Part of a map showing location of How’s New Cave.
This map was found on the same DPIWE file as the 1879 letter from Smith to O’Reilly.

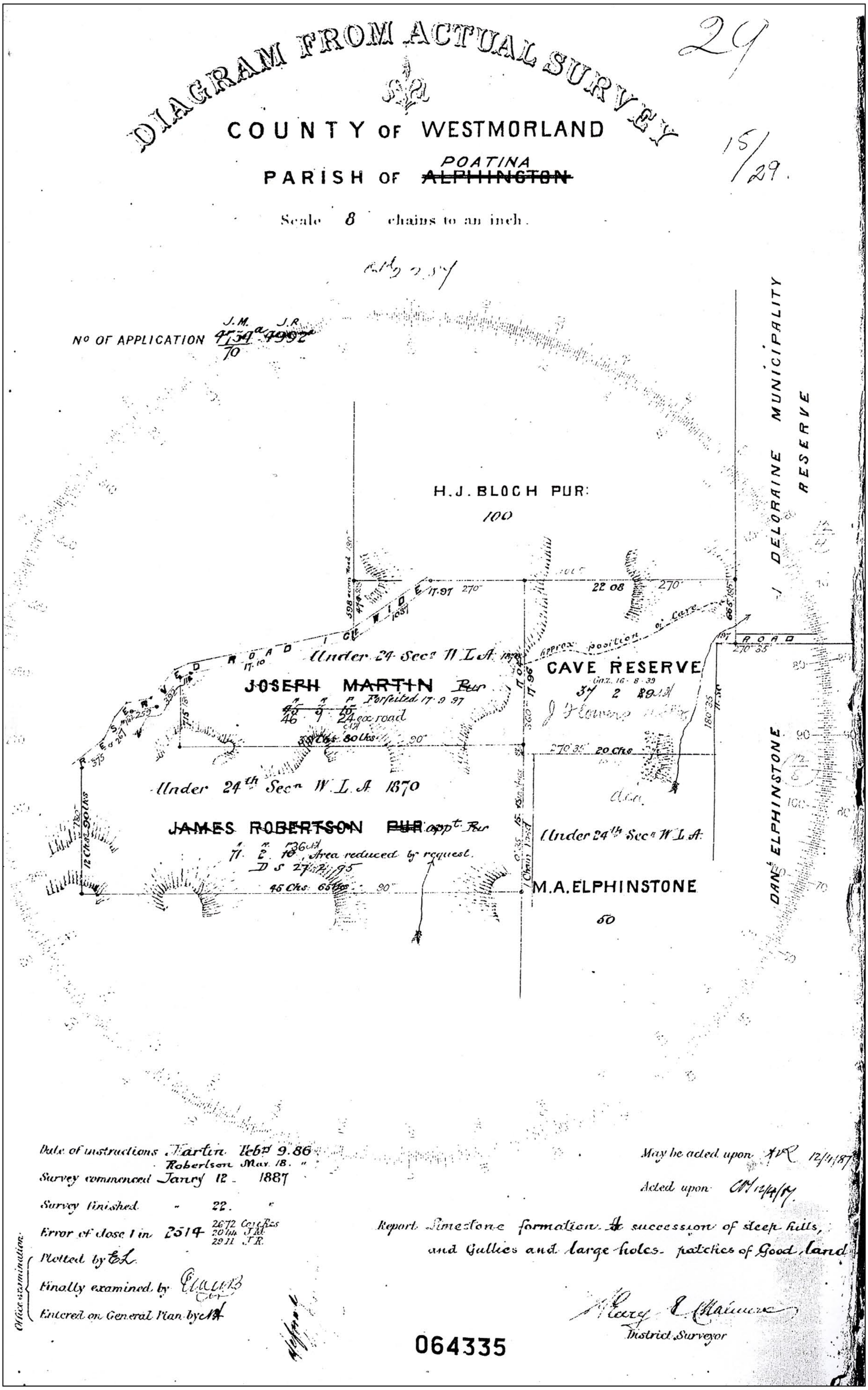

Figure 2: Title plan for the cave reserve at Cyclops Cave ("How's New Cave") dated 1887.

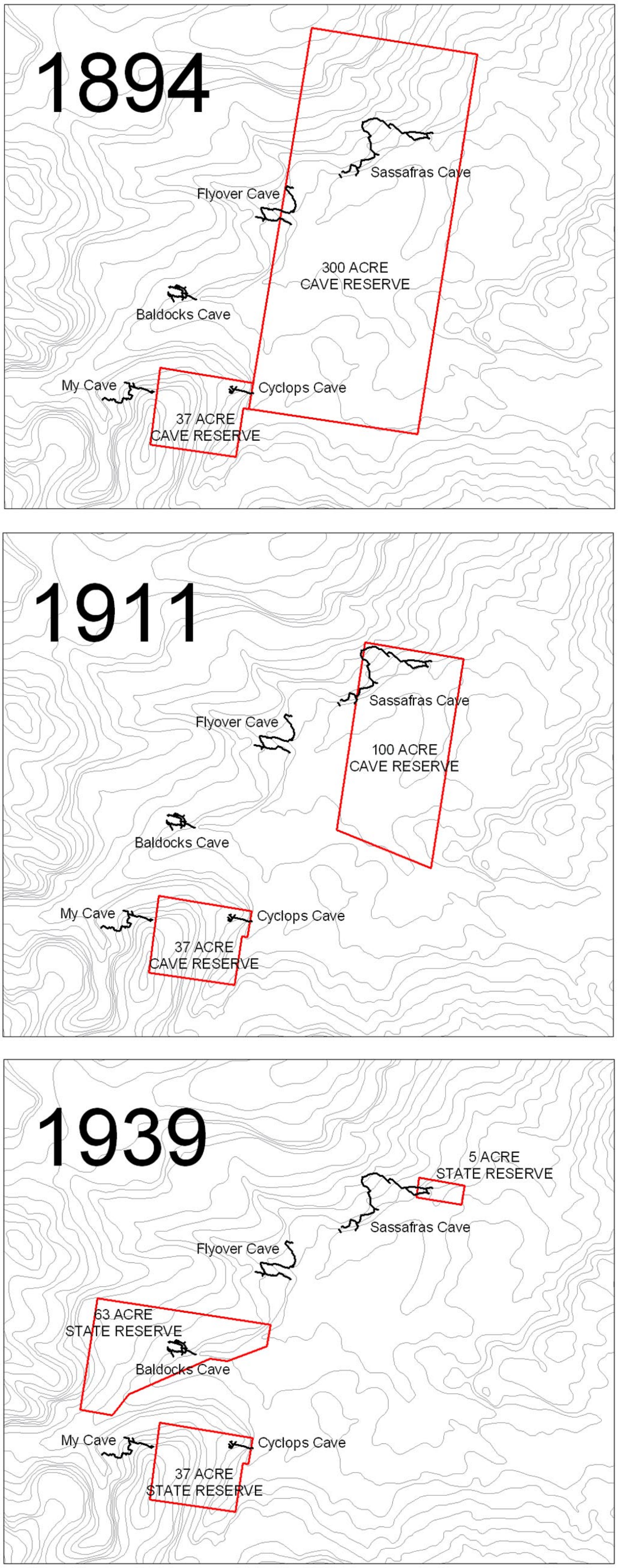

Figure 3: Reserve boundaries at Sassafras Creek from 1894 to 1939.

'FAST' KARST
– AN INTRODUCTION TO TASMANIAN CAVE TOURISM IN THE YEARS 1840 - 1950

Nic Haygarth
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KARST was one of Tasmania's first tourist attractions. The karst of the Mole Creek region was first reported in 1823, when Captain John Rollands noted some "circular pits or ponds"[1], in the area subsequently named "Circular Ponds". (Later known as Mayberry, this area is located along the Liena Road, just north of the Marakoopa Cave system.) Also referred to as "circular basins"[2], these pits are the features we know today as dolines; the "ponds" are in fact drowned dolines. The subterranean creeks, limestone caves and dolines of the Mole Creek region[3] in northern Tasmania were first examined in more detail by surveyors of the Van Diemen's Land Company in the mid to late 1820s while cutting a stock track from the Western Marshes (near Deloraine) to Emu Bay in north-western Tasmania. This route later evolved into the main road west of Deloraine. One of our first documented records of a tourist visit to caves in Tasmania relates to Lieutenant-Governor Arthur's visit to an unknown cave near Mayberry in January 1829[4]. More karst features were soon discovered in the surrounding district and by 1850 caves of the Mole Creek region were being marketed as a tourist attraction.

The physical barrier of Bass Strait, along with the island's small population, restricted its tourist numbers and slowed the development of its cave tourism industry. The power of the box office is such that, while the Mole Creek caves were discovered, almost simultaneously with the Jenolan Caves in New South Wales, the former lagged decades behind in terms of local and colonial governmental protection, infrastructure and lighting systems. Until about 1920, cave tourism in Tasmania was characterised by individual initiative and voluntary "booster" organisations, but ultimately it was the State government which shaped the present regime of "show" caves at Mole Creek, Gunns Plains and Hastings. In the post-World War II period, the formation in Hobart of the Tasmanian Caverneering Club signified a firmer recognition of the intrinsic value of karst and caves, rather than just their pecuniary value as a tourist attraction. Four phases in the development of Tasmanian cave tourism during the period 1840 – 1950 are apparent.

1: WESTWARD HO: THE PIONEERING PHASE FROM ABOUT 1840 TO 1870

In the years from about 1840 to 1870, an *ad hoc* form of tourism existed in the Mole Creek district. During the second half of that period it centred on an upwardly mobile ex-convict named Dan Pickett and his establishment: the Chudleigh Inn. (The town of Chudleigh takes its name from a town with tourist caves in the English county of Devon.) Pickett boasted that he had guided a succession of Tasmanian governors through the Wet Caves, beginning with Sir John and Lady Jane Franklin in about 1840, and also implied that he had attended the famous Eton school in England prior to emigrating here as a free settler! Such lies or "mis-truths" probably did no harm to the ex-burglar's reputation as raconteur and entertainer.[5]

Initially cave tourism was focused on one cave system: variously reported as the Western, Westward, Oakden, Chudleigh or Wet Caves. The two caves here are known today as Wet Cave and Honeycomb 1. The main entrances of both caves are only a few hundred metres apart, located at each end of a surface breach in a subterranean tributary of the actual Mole Creek. Wet Cave was the site where Tasmanian cave fauna was documented for the first time, when Lieutenant William Breton reported glow-worms during a visit to the cave in September 1842.[6] Twenty years later another set of "new" caves had been discovered further west on Sassafras Creek; subsequently known as "How's Sawmill Cave" (Sassafras Cave) and later as the "New Caves", these were also being visited by tourists in 1862.[7]

Aside from the Chudleigh Inn, and the guiding service offered by Pickett and/or on an impromptu basis by local farming families, there was no infrastructure for cave tourists. There were none of the safeguards for tourists or caves that generally apply today: no cave gates, no authorised guides or caretakers, no in-house electric lights, no ladders, no bridges, no cement paths or protective wire. One of the results of this was unchecked vandalism: removal of speleothems and the proliferation of speleograffiti signatures. Bark torches and sperm whale oil candles lit the way, and the answer to wading through cold, often knee-deep water was not thermal underwear, but a bottle of brandy. Glow-worm displays, playing the "organ pipe" flowstone ribbons, autographing the 'Registry Office', the thrill of the "sublime" and the excitement of journeying underground characterise reports of early visits to the Wet Caves.[8]

Apart from the few local residents, only the more wealthy "well-to-do" saw the caves at this time, the reason being that a trip from Launceston to the Wet Caves took several days by horse and dray. The working class could not afford such a trip and did not have the leisure time it required. The most famous visitor was English novelist Anthony Trollope, who in 1872 accompanied Governor Du Cane to the Wet Caves, with Dan Pickett as their guide.[9] Even prior to the publication of Trollope's travel book *Australia and New Zealand*, tourists' handbooks such as Thomas's *Guide for Excursionists to Tasmania* began to promote Tasmanian attractions on the mainland. Until 1885 there were no Bass Strait steamers, so crossing the Strait was a long, uncomfortable battle with winds and waves.[10]

In about 1861, limestone caves were also discovered at Flowery Gully on the western side of the Tamar River near latter-day Beaconsfield, probably as the result of a tramway being built nearby to exploit timber for the gold rush market in Melbourne.[11] Known variously as the Ilfracombe Caves, Winkleigh Caves or the West Tamar Caves, the caves at Flowery Gully appear to have received visitors only sporadically, the main reason for this possibly being that they were on private land. Similarly, there was no local entrepreneur like Pickett to promote these caves, and they were essentially in the middle of what became in the 1870s probably Tasmania's busiest mining district.

2: RAILWAY DAYS: FROM LAUNCESTON TO "FAIRYLAND"

In 1871 Tasmania's first railway line was opened between Launceston and Deloraine, which brought a small urban population within 18 kilometres of the Mole Creek caves. That distance was further reduced when in 1890 the Mole Creek Branch Railway ushered in the day trip, finally enabling Launceston's working class to see these caves. At this time, a cool, temperate climate was considered curative and invigorating, and the 'Englishness' of rural northern Tasmania, with its rolling hills and hawthorn hedge windbreaks – even blackberries – also appealed to British subjects in the Antipodes.[12]

In 1879 the Deloraine Council made the first efforts to protect the caves, the catalyst probably being the theft of a large formation called "The Cauliflower" from the "New Caves" (Sassafras Cave).[13] The "Old (Wet) Caves" were enclosed by a 100-acre (40.5-hectare) reserve, a 300-acre (121.5-hectare) reserve enclosed Sassafras Cave and a smaller less well known 37 acre reserve was created around "How's New Cave" (known today as Cyclops Cave)[14]. These first cave reserves in Tasmania were effectively municipal reserves: three areas of crown land leased to the Deloraine Council on the proviso that Council protect the caves, as well as providing and maintaining access roads to the caves. Subsequent to these reserves being declared, the Deloraine Council was petitioned by local graziers and timber getters in the 1880s to sub-lease the reserve lands and to assist the *Chudleigh Road Trust* to provide access roads. By 1909, that 300-acre reserve was already down to 100 acres, after locals pressured the Deloraine Council to let them cut timber on the land.[15] The *Crown Lands Acts* of this time were "toothless", guaranteeing little more than that reserved land would not be sold. That reservation of land was not a popular movement at this time is borne out by a glance at a map of today's Mole Creek Karst National Park, which shows a block of only two hectares covering the entrance to Sassafras Cave. Similarly, both Council and Tasmanian Lands Dept. never honoured the original intent of these cave reserves by creating legal access roads, so consequently the Sassafras Cave reserve is now an "island" – surrounded by private land – without a legal access road for visitors.

In the early 1880s Baldocks Cave was discovered near Sassafras Cave, and it was from here that the Tasmanian Cave Spider (*Hickmania troglodytes*) was documented for the first time in 1883.[16] For a few years during the late 1880s/ early 1890s, William Baldock became Tasmania's second example of individual cave entrepreneurship. In the 1890s, Tasmania had no government tourist authority, relying on voluntary organisations like the Northern Tasmanian Tourists' Association (NTTA) to promote the colony and its tourist attractions. Acting on the advice of visiting Jenolan Caves guru J.C. (Voss) Wiburd, the NTTA induced the Tasmanian government to buy Baldocks Cave and place it in the association's protective custody. Part of this protective regime was the 1902 appointment of David Howe as Tasmania's first "official" cave caretaker at Baldocks. [17]

When the Railways Department introduced the special excursion fare day trip in 1894, the two sets of tourist caves at Mole Creek: the "Old Caves" and "New Caves" were respectively marketed as the "Wet Caves" (today's Wet Cave and Honeycomb 1) and the "Dry Caves" (Baldocks Cave and Sassafras Cave), emphasising two contrasting cave experiences. Both sets of caves had caretakers (appointed by the Deloraine Council) who acted as cave guides, charging set fees to visiting tourists. The railway excursion fare included the cave entry fee. The typical description of the Mole Creek caves late in the 19th century and early in the 20th century was as a "fairyland", "fairy grotto"' or a "magical paradise", which reflected both contemporary fascination with the supernatural and the gradual replacement of candles by the more vivid magnesium ribbon and acetylene powered lamps.[18]

Limestone caves were discovered at Ida Bay, south of Dover in the late 1880s, but access initially required a boat trip and long walk. In around 1894, tourist caves were found at Gunns Plains, in the north-west and near Kelly Basin in western Tasmania in 1899.[19] All these discoveries were on Crown Land. Like those at Flowery Gully, the caves at Ida Bay and Kelly Basin were soon threatened by proposed limestone quarries, and development at Gunns Plains was hampered by its isolation.

3: "TASMANIAN WONDERLAND": THE HEYDAY OF PRIVATE CAVE TOURISM AT MOLE CREEK

The heyday of private cave tourism in the Mole Creek region early in the 20th century was characterised by the use of acetylene lighting, a technology which reigned for two decades. Local farmers became entrepreneurs exploiting the custom brought to the district by the Mole Creek Railway. The westward spread of settlement guaranteed new cave discoveries such as the Alexander Caves (Scotts Cave), King Solomons Cave and Marakoopa Cave, this being the only truly competitive period in the history of Tasmanian cave tourism.[20]

Scotts Cave at South Mole Creek was as famous for its hospitality as its limestone marvels, if the epiphanies contained in its visitors' books are any guide. The Scott family kept a boarding-house on their property and guided tourists not just to Scotts Cave, but to the Chudleigh Lakes on the Great Western Tiers, plus the Den and Alum Cliffs on the Mersey River.

King Solomons Cave near Liena, developed by the blustery entrepreneurship of EC James, is in some ways perhaps the ideal show cave, compact and colourful, guaranteeing the visitor almost instant gratification. In its early days it featured an underground cafe. Like Scotts and Baldocks, its original entrance demanded physical agility.

Marakoopa is a much bigger cave system than either Scotts or King Solomons, containing more spectacular formations and a glow-worm chamber for an entrance hall. Pious Baptists, the Byard family who developed the tourist cave at Mayberry sang hymns within the cave, which they lit cheaply but dimly with hand-held acetylene lamps. The ethereal resonance and shadows which resulted appealed to Hobart novelist Marie Bjelke Petersen, whose best-selling romance *The Captive*

Singer, set anonymously at Marakoopa Cave and the town of Mole Creek, advertised Tasmanian karst across the British Commonwealth.[21]

The advent of the private motorbike or car introduced motor touring to the caves. Skilled black-and-white photographers, including Steve Spurling, John Watt Beattie and HJ King, helped promote the tourist caves. It was during this period that stereotypic guided cave tourism, in which every formation had an official name and story, began to erode the sense of discovery that earlier cave visitors experienced.[22] Nevertheless, the word "wonderland" and the phrase "Tasmania's wonderland" or "Tasmanian Wonderland" gradually replaced "fairyland" as the typical cave metaphor; "wonderland" being a reference to Lewis Carroll's *Alice's Adventures in Wonderland*, which had remained in print since its initial publication in 1868.[23]

4: EMMETT'S TEMPLE: THE CAVES IN GOVERNMENT HANDS BETWEEN THE WARS

In 1914 the Tasmanian Government Tourist and Information Bureau was established in recognition that the state needed a unified effort if it was to compete for the tourist pound (£) with the mainland states and New Zealand. In 1915, with the passing of the *Scenery Preservation Act*, Tasmania went from having ineffectual environmental legislation to having what has been called the most progressive of its kind in Australia.[24] This reflected a growing interest in conservation, although those who wanted to preserve nature found themselves having to side with tourism boosters like ET Emmett, director of the Government Tourist Bureau, in order to establish Tasmania's first national park, at Mount Field.[25]

Emmett was the dominant figure in Tasmanian cave tourism between the wars. He led the annual four or five-day Easter trip by rail to the Mole Creek district, which took in Baldocks, Scotts, Marakoopa and King Solomons Caves, plus other local features such as Westmorland Falls and the Alum Cliffs.[26]

The Government Tourist Bureau's attachment to the Railways Department signaled that the government wanted to protect its railways from the increasing competition provided by road transport. The Tasmanian Railway Department had been at the forefront in providing government assistance for organised tourism in Tasmania, but it was also a means of helping to repay the costs of laying the lines and purchasing rolling stock.

The railway excursions to tourist destinations were still very popular. Reflecting the growing interest in conservation of tourist assets, one of the very first public notices relating to the protection of caves in Tasmania (under the control of the Govt. Tourist Bureau) was issued as a "Railway Department Notice" in 1921, with a set of By-Laws coming into effect on June 1st that year.[27] The by-laws introduced a set of penalty fines stating that admission to the caves required being accompanied by a guide who had the authority to restrict entry by intoxicated persons or those with a physical disability. There were also provisions for protecting the fauna, "eggs" and flora of cave reserves along with penalties for defacing the cave formations and cave rock (with any writing or marking) and causing "injury" to any rock, stalactite or stalagmite.

For about a decade the Easter trip to the Mole Creek Caves was conducted by railway, but by the late 1920s Emmett found it more convenient to use hire cars, a shift away from the train which culminated in the Tourist Department becoming an independent body in 1934.[28] The slogan "Tasmanian Wonderland", formerly a description specifically used to promote the caves, was adopted by the Government Tourist Bureau as the logo for its Tasmanian tourism package.[29] The advent of regular air services and the establishment of mainland branch offices of the Tasmanian Government Tourist Bureau helped sell this package.[30]

Around this period, in late 1917 and early 1918, three dolomite caves were discovered by timber loggers near the end of their tramway in the forest about 10km west from the Hastings Mill, situated on a bay in the estuary of the Lune River, almost directly north from Wheelbarrow Bay (Ida Bay). The three caves: Newdegate Cave, The King George Cave (now King George V Cave) and Beattie Cave collectively became known as the Hastings Caves, though today this name is used synonymously for Newdegate Cave, the sole remaining most visited tourist cave in Tasmania. Newdegate Cave was the first to be discovered, shortly before Christmas in 1917, reported in newspapers in mid-February 1918.[31] About ten days after several newspapers published conflicting accounts of their discovery and size of the entrance – then, travelling by "motor" and "horse train" – the caves were inspected by ET Emmett in the company of wilderness photographer: JW Beattie.[32] Barely three weeks later, using the new Hastings Caves discovery as his "show-piece", Emmett provided an illustrated address on the *Caves of Tasmania* to the Annual General Meeting of the Royal Society of Tasmania.[33] The two other new caves at Hastings were discovered early in 1918 and all three caves featured in a subsequent lecture by JW Beattie to the Royal Society at their April 1918 meeting, illustrated with a series of 36 lantern slides[34]; some of these slide images were subsequently published in newspapers.

Although a 131 acre Hastings Caves Reserve was gazetted 14 months later on June 24th 1919, the government did little to physically protect the caves from damage by visitors. All three caves were reguarly visited by local people and their families, sometimes accompanied by self-appointed cave guides who encouraged their touring parties to sign their names at designated signature sites in cave chambers. Early in 1920, Emmett wrote to the Esperance Municipality Council requesting that all three caves be gated and later that same year, the Tasmanian Government agreed to a request from the Scenery Preservation Board that the caves at Hastings be vested in the control of the tourist section of the Railways Department. Despite the best intentions of the Government and the Esperance Council, the caves continued to be vandalised until control was temporarily vested in the hands of Council while Parliament debated the cost of constructing a road and formally developing the caves for tourism.

The Esperance Council established a series of graded walking tracks with excavated pathways to the caves and for a short time in the 1930s, all three caves were open to tourists. One of the enterprising guides appointed by the Council had an especially designed truck for excursionists with wooden bench seats installed with rope lashings in the boxed-in tray compartment behind the driver's cabin. The guides charged tourists an entry fee for public inspection of the caves and visitors books were placed at all three cave entrances in an effort to prevent further desecration of cave formations with signatures. Cave guides used a mix of lighting methods including kerosene lanterns, carbide lanterns (removed from bicycles) and hand operated dynamo powered electric torches.[35]

Despite the threat of limestone quarrying, the caves at

Ida Bay and those near Kelly Basin on Macquarie Harbour were also being promoted as tourist attractions in the first and second decades of the 20th century. Both sites were accessed along tramways: a timber logging tramway at Ida Bay, via "The Avenue" – a branch line from the Lune River Mill tramway – and near Kelly Basin on the west coast: the former North Lyell Railway from Gormanston to Pillinger, via the old mining towns of Crotty and Darwin. A 40 acre cave reserve at Ida Bay to protect the "Ida Bay Caves" (Mystery Creek Cave) was gazetted on July 3rd 1917, by notice from the Tasmanian Department of Mines under auspices of section 16 (2) of the *Mining Act 1905* to "preserve the caves situated thereon". The caves on the Bird River near Kelly Basin eventually lost their appeal as tourist destinations, following the decline in supporting infrastructure with the demise of the nearby towns several years after the collapse of the former North Lyell Mining Company.

By the time the *Scenery Preservation Act 1915* was passed and the Scenery Preservation Board was formed to administer the act, it was obvious that farming families could not raise the money to fully develop their own caves. As a result, the government bought King Solomons and Marakoopa Caves. So now five cave systems – Gunns Plains, Baldocks, King Solomons, Marakoopa and Hastings – were in government hands, leaving Scotts as the only privately-owned tourist cave. Flowery Gully was still privately owned, but limestone quarrying prevailed over tourism there, despite a short respite in 1933. At that time, a Launceston businessman, Bill Annear, installed a 32-horsepower electric light plant outside the caves, which were officially opened to the public by the Mayor of Launceston.[36] It is interesting to note that this electric lighting at Flowery Gully occurred around six years ahead of the electric illumination of present-day tourist caves: Marakoopa and Newdegate.

The Scenery Preservation Board was starved of funding until the mid 1930s.[37] It was actually local improvement associations, not the Scenery Preservation Board, which ran Gunns Plains and Hastings Caves during this time, and which ensured that in 1928 Gunns Plains was the first Tasmanian cave to receive the electric light.[38] The "old" Mole Creek caves were administered by the Railways Department through the Government Tourist Bureau. The little money available for their development was focused on King Solomons, which was electrified a few months after Gunns Plains.[39]

In the late 1930s the Ogilvie government spent heavily on tourism in the name of unemployment relief, which included the epic task of labourers with hand tools working all seasons in deplorable conditions over several years to form the 11km long stretch of road to open up the Hastings Caves.[40] Although a considerable section of this new caves road was formed through forest and swampland, much of it followed the route of the former timber tramline from the Hastings Mill, running roughly parallel to the course of Hot Springs Creek. By 1939, the present regime of four major tourist caves, each with electric light, King Solomons, Marakoopa, Gunns Plains, and Newdegate Cave at Hastings, was established. Even Flowery Gully had the electric light, some of which can be still seen today hanging "lifeless" from passage walls in the cave now only accessible from the one remaining quarry-face entrance. The two remaining tourist caves at Mole Creek which were not electrified, Baldocks and Scotts, fell by the wayside.

CONCLUSION

In September 1946 Dr Sam Carey founded the Tasmanian Caverneering Club (TCC), Australia's first speleological organisation, in Hobart. This signalled acceptance of the idea that karst had an intrinsic value aside from its pecuniary one. The club's investigation of existing "show" caves, at the request of the Scenery Preservation Board, prompted the opening of new tourist chambers including Binneys Chamber in Newdegate Cave,[41] named in honour of the TCC's patron, Governor Hugh Binney.

TCC were requested to investigate and survey a number of caves, preparing reports and detailed maps for the Scenery Preservation Board on nearly all the operating tourist caves, plus the closed sites including Baldocks, Scotts and Flowery Gully making recommendations on the viability of possible future tourist operations. In 1947, members of TCC were guided to a cave on the south side of Marble Hill at Ida Bay where they searched for the exit passage from Mystery Creek Cave in the hope of discovering yet another potential tourist destination; this "new" site became known as the Exit Cave. In subsequent years, TCC members became more and more focused on finding and exploring new caves with early attention paid particularly to the karst areas of Mole Creek, Junee-Florentine, Hastings, Gunns Plains, Loongana and Ida Bay. Caving as a recreation in Tasmania now developed independently of the tourist caves.

There was a rapid expansion of tourism in Tasmania in the immediate post-war period, probably due to many people having postponed their travel during the hostilities of World War II.[42] This trend did not last, though, with successive Tasmanian governments being more interested in luring secondary industry to the state with cheap hydro-electric power, rather than chasing tourists.[43] A small population and the physical isolation, still cost Tasmania the benefits that the mainland states gained from an increase in motor touring in the early 1950s.[44] Not until the roll-on, roll-off Bass Strait ferry *Princess of Tasmania* made its debut in 1959 was there a resurgence in tourism, but not even that service could give Tasmania parity with mainland "show" caves.[45] ■

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PROBLEMS OF SURVEYING THE BULLITA CAVE SYSTEM

– THE LONGEST CAVE IN AUSTRALIA

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INTRODUCTION

This presentation is to examine the problems of surveying this very extensive cave over the last fifteen years, to encourage discussion with other cave surveyors and to improve the management of surveying extensive cave systems. This annual survey project has required a great deal of planning and preparation because expedition members, survey techniques and computer programs are continually changing.

Surveyors of Bullita Cave are always working under difficult conditions because of the area's remoteness and the nature of its climate. Intending expedition participants are made aware in advance of what to expect during two weeks of working in such a location.

Waddington (1998) says that a large cave surveying project is "*essentially any cave survey where a surveyor cannot find or identify a previously used survey station from recent memory. This may be because personnel has changed and the surveyor has not been in the cave before, or because the station to be found was last used a long time ago and (its location) has been forgotten, or because the cave is so extensive that it exceeds what one person can remember'.*

Which cave has 268 separate surveys, more than 10,000 survey legs, 9,100 survey stations located in an area of 4 x 1 kms, 1,400 survey loops, more than 40 entrances and more than 100 kms of surveyed passage? The answer is the Bullita Cave System in northern Australia. Figure 1 shows the length of Bullita Cave compared with thirty-nine other well-known "long" caves in Australia (ASF Karst Index). Many speleologists who have taken part in the survey have also been on major expeditions elsewhere in Australia and overseas but the surveying of Bullita Cave poses problems quite different from those encountered in smaller and less complex caves.

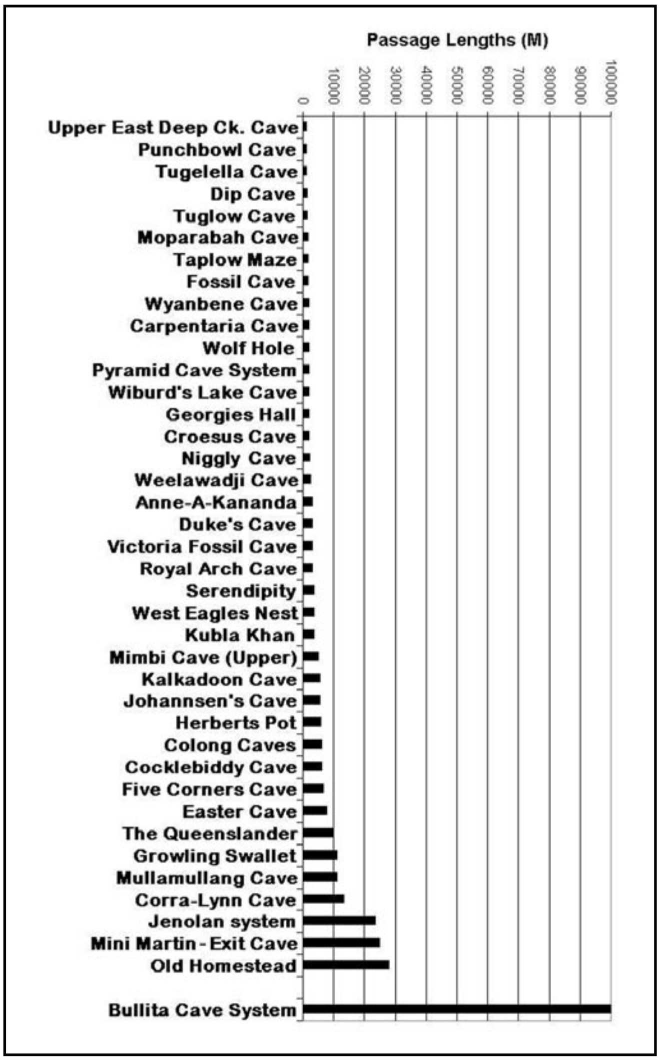

Figure 1: Comparison of passage lengths of Australia's longest caves.

ENVIRONMENTAL AND BACKGROUND PLANNING PROBLEMS

Weather

The weather conditions have to be suitable. The best time of year to visit the cave is during late June and early July. From December to March the onshore northwest monsoon winds of northern Australia bring torrential rain and very high temperatures. In contrast the number of rain days in June/July is very small and there is plenty of sunshine and low humidity. This helps to evaporate any water remaining in the cave. The temperatures are still high during the day but nights can be quite cool (Figures 2 and 3).

Remoteness

Caves in northern Australia are remote from major capital cities where most cavers live. Trips require a duration of one week or more. Participation in Bullita expeditions needs a great deal of preparation whether one drives or flies to Darwin and hires a vehicle. Because winter is the peak holiday season in the tropical North, most of the cheap air tickets are sold well in advance and vehicles may be difficult to hire.

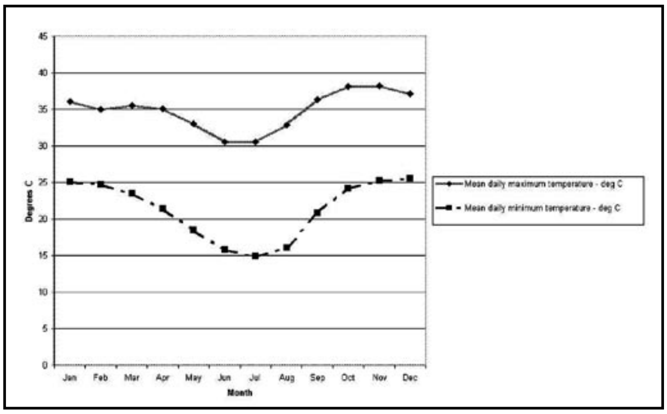

Figure 2: Variation in mean monthly temperatures in the Bullita area.

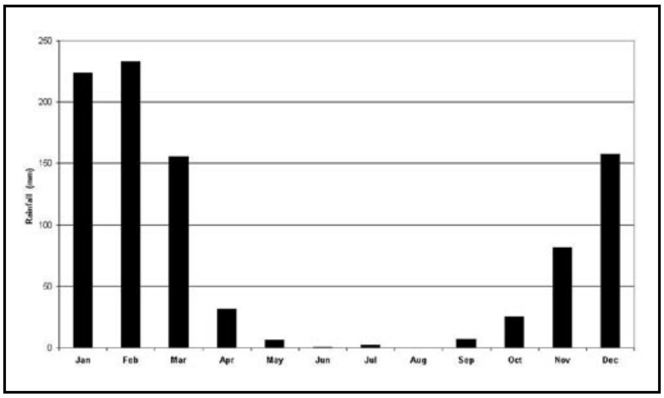

Figure 3: Variation in mean monthly rainfall in Bullita area.

Participation and Changing Personnel

Each year the group is made up of disparate cavers from all over Australia who quickly have to learn to work as a team and accept the control of the expedition organisers. During the past fifteen years 55 individuals and 17 rangers from the Northern Territory Parks and Wildlife Commission (PWC) have contributed a total of 1800 days to take part in surveying this very extensive cave system. Figure 4 shows the participation rate of those members who have taken part over the last fourteen years. The "corporate memory" of the original core members is fading and information about the area and the cave has to be passed on to more recent participants in the annual expeditions.

Team Work and Cost Sharing

Members of the expeditions have to agree to the conditions of the permit and must be willing to be part of a collective effort for two weeks. This involves camping and working together under a variety of conditions, cooking and cleaning communally, not having hot water for showers, doing your own laundry by hand and sharing all expenses. Expenses per person amount to some $500 and that does not include your travel expenses to reach the site which can also amount to several hundred dollars.

Hygiene

Food is frozen or refrigerated. The one available toilet stretches the ability of the septic system to cope. For this reason showers inside the Rangers "Donga" are banned. We either have cold showers outside or swim in the creek at the end of the day, often after the sun has set.

Risk Management

So far no major accidents have occurred. Every year we have several members with first aid qualifications and an ex-nurse is present at the camp. Minor injuries do happen and insect bites are a regular occurrence. A risk management strategy is in place and one expedition member carries a satellite telephone to the survey area each day. It is also a requirement for each member to leave in camp a personal form with emergency contact and medical history details. Each day a "daily whereabouts sheet" is left in camp for the information of the camp warden and rangers in case of a late return of the party. Prearranged return times are agreed to each day and if several parties are working in the same general area they wait for each other and return together. Parties do not leave from the swimming hole until everybody has returned unless by prior arrangement.

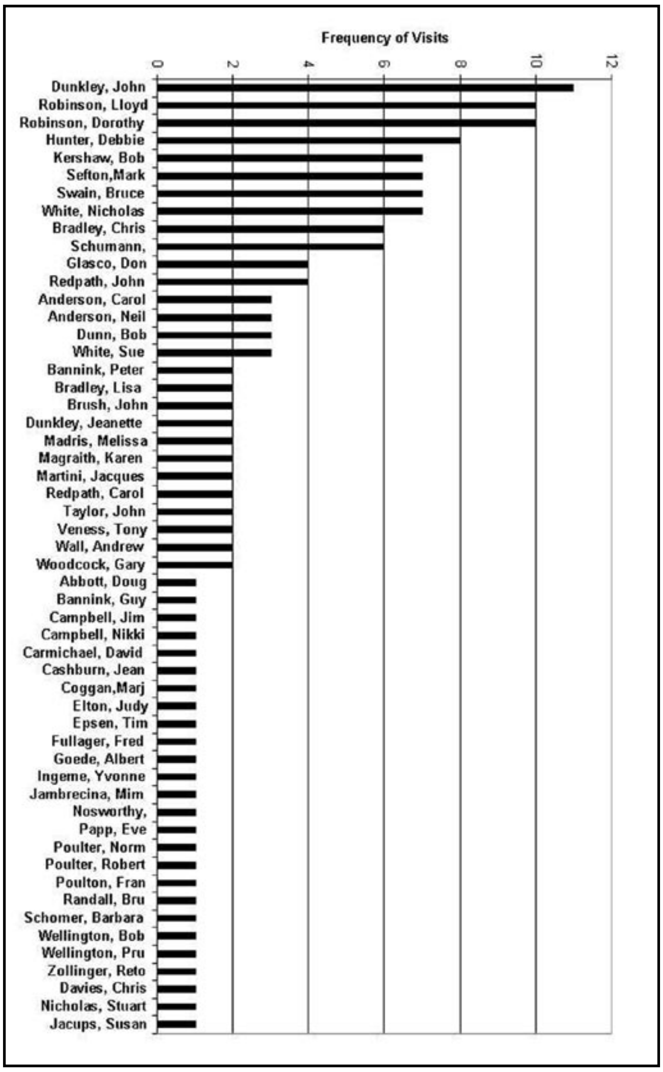

Figure 4: Participation frequency of Bullita expeditioners.

Biology

Some cave dwellers such as spiders and wetas regularly occur underground. We often come across dead kangaroos that have fallen down a vertical entrance from the surface. If the carcass is "fresh" it may be necessary to curtail surveying in the area until the following year. Snakes have been encountered underground. The Mulga Snake (formerly known as the King Brown) is common in the area.

Miscellaneous

Breakfast is eaten "on the run". There are no cooked breakfasts and lunches are prepared at breakfast time. We have to depart by 0830 because later in the morning the 3-5 km walks to the cave become unbearable due to the high temperatures. We return to the creek at approximately 6 pm for a swim and return to camp at about 7 to 7.30 pm for a late dinner. We do this to avoid walking in the heat of the day. Most members are off to bed at 9 pm.

SURVEYING

The Bullita Cave survey is a project with five major data files saved in the Compass Survey program that incorporates 268 separate surveys with over 10,000 survey legs, 1,400 loops and involving more than 40 entrances. When printed in Arcview there are over forty A3 size map sheets each depicting an area of 250 x 250 metres. The problem is how to keep track of the survey data and maps as well as undertaking another 5 to 7 km of surveying on each expedition.

Survey Stations

In the early years of exploration, small pieces of flagging tape were used to identify survey stations and toilet paper was used one year when tape ran out. Unfortunately many of these early markers have disappeared. When we come across one we have to ascertain its number. Each station is now marked with a good sized piece of flagging tape tied to it. In the case of prominent survey stations aluminium garden tags are attached to cairns or walls with electrical cable ties. The tags are either stamped prior to the trip or in the cave.

We do not survey over or through areas of unique speleothems. We may pass a tape through to complete a loop or tie into another survey.

Many early stations were placed in the middle of the passage, and unbeknown to the surveyors involved, were washed away after torrential rainfalls as they were in the middle of streamways. CSS members had problems with surveys done by TESS. They could not relocate survey stations because in line with conservation policies they were tiny pencil marks on a wall.

Mapping

Declinations were not taken in the early years of the survey as there were few if any computational programs that could deal with such data.

This was a mistake as very good survey programs are now available and declination data would have made the early maps more accurate. We have not yet returned to resurvey the many kilometres of passage that were surveyed in this way. Stations are in numerical order in the Bullita Cave system but similar numbers have been used in surveying other cave systems in the area. To avoid confusion we now use a unique station identifier: the year prefix followed by a 4, 5 or 6 figure station number. For example: 97703 (1997 station 703) or 04318 (2004 station 318). They are used only once in the whole area and cannot be confused with any other station unless an error is made in the central register.

We survey and sketch as we go to a scale of 1:1000 and these maps are often used to find our way out and back in again. This system has enabled the cave survey to progress successfully. We often have end of the day excursions into new passage for several metres to encourage us to return the next day to add to the survey.

This system should be used for any successful cave exploration. While it stifles the excitement of quickly exploring new passage, it insures that surveying is completed to a high standard.

A composite map of A3 sheets is often taken into the cave to assist in navigation if a long underground journey is planned. Occasionally we are able to use the PWC photocopier and are able to make a composite map of several sketches that have been drawn in the same new area over several days.

Each data sheet has an area prefix, year and survey number label. The survey sketch also has the same data and these details are recorded in a central register for each year. The central register is controlled by a single person who allocates numbers on a nightly basis and enters those numbers in the register with the team leader.

The date and location of the survey to be done the following day is pre-recorded. This is checked each night and the process continues for the duration of the expedition. If it were not for the register, there could be confusion when three to five surveys at different locations are carried out each day for a ten-day period.

The updated maps are drawn prior to next year's expedition and often a sheet is redrawn year after year so that minor reinterpretations can creep in. The updated maps carry the updated date so that we can identify the latest version of each map.

There can be minor problems in patching together different sketch maps done by different individuals. A master set of maps remains in Canberra and three sets are taken to Bullita each year. Two are used as field sets and the third copy remains in camp in case it is needed in order to locate a missing team. This has not yet happened! We have decided that we will only draw finished geo referenced maps when the cave survey is complete and we have transferred the data to GDA94.

Technology

In the first few years of surveying, data reduction was done using a CEGSA program. This system caused problems because it did not close loops and was notoriously slow to accept amendments and corrections. Now a computer is used to enter new data into the COMPASS survey program. This is sometimes done on site but usually after we return home. The COMPASS program allows us to check for errors and to compare the original sketch with the COMPASS plot line and correct any errors. The plot lines are then imported into ARCVIEW to relate them to geographic coordinates. GPS data of cave locations are entered into the GPSU utility program.

Recently data have been used to overlay plot lines on an aerial photo using ARCVIEW. Data in ARCVIEW are in GDA66 but that will soon change to GDA94. We soon found that computer use in the field reduced after dinner socialisation time so computer use after 5 pm has been banned.

Other Matters

Compasses are checked for errors due to magnetic intrusions such as metal frame glasses. If an error is found the relevant survey legs have to be resurveyed.

There is a great deal of terminology that participants soon become used to, such as "Neighbours Block", "Berks Backyard" and "SOGS". Acronyms such as SLOP and LOSP refer to "shit loads of passage" and "lots of shit passage" respectively. Nowadays we tend to target specific areas for surveying so that portions of the cave system can be completed and a final map drawn up.

Surface trogging, Bullita.

CONCLUSIONS

To achieve a trouble-free and productive expedition, it is just as important to take into account the background planning as the actual surveying. With the use of new technology and computer programs, we have been able to accurately locate the cave in relation to surface features. This has facilitated the location of new entrances that will enable us to conduct surveys in formerly remote parts of the cave system for many years to come.

ACKNOWLEDGMENTS

I would like to acknowledge the assistance of Mark Sefton of the Cave Exploration Group of South Australia, John Dunkley of Highland Caving Group and Albert Goede in producing this article.

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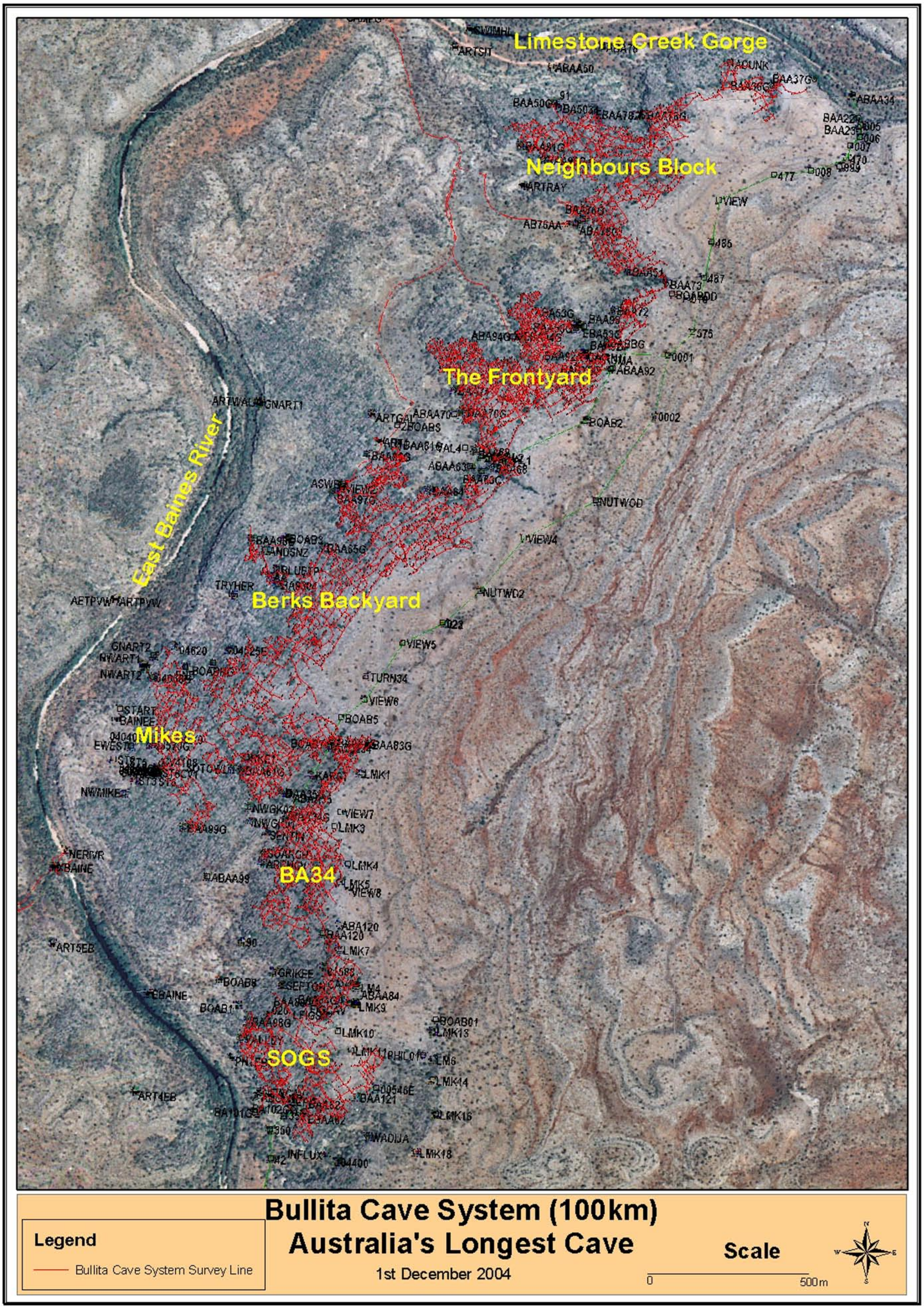
BULLITA CAVE SYSTEM AERIAL PHOTO

Bob Kershaw
Illawarra Speleological Society



An aerial photo showing the approximate location of the Bullita Cave system in relation to the surrounding landscape.

THE ASF'S NATIONAL KARST INDEX DATABASE

– AN OVERVIEW OF THE UPDATING FEATURES

Mike Lake
2 Derringbong Pl Thornleigh NSW 2120

The ASF's National Karst Index Database has been running since January 2001 and it accounts for the majority of the visits to the ASF's web site.

Until now that database has been read-only. The reason for this was that the database is quite complex and when initial coding was started in 2000 we decided to "walk before we ran". In hindsight that turned out to be a good idea.

Over the last year the code underlying the database has been extended to provide updating functionality. The codebase now runs to 100,000 lines of code. We have data updating, auditing, attribution and automatic PDF generation of cave summary forms.

The KID is also a working implementation of the UISIC standard for Cave & Karst databases. As the code is released under the GPL, other countries can adopt our system, although for some languages considerable work in internationalisation would be required.

This talk presented an overview of the new functionality and encouraged clubs and other organisations to contribute to updating Australia's national karst index database. The first online update of the KID was ceremoniously performed by Grace Matts who updated 2WA-17, Deep Hole, at Walli Caves. Significantly, it was Grace who made the earliest recorded entry into the original KID in 1970 for 2MC-1 at Moore Creek, NSW. ■

PHOTO: JOE SYDNEY

Mike Lake instructs Grace Matts in making the first online update of the ASF Karst Index Database .

VIDEO SEMINAR

DIGITAL PHOTOGRAPHY

– ITS LIMITATIONS AND WAYS AROUND THEM IN THE CAVE ENVIRONMENT

Angus R. Macoun

Digital cameras are becoming popular and many people are hardly using their film cameras anymore.

This is due to the perceived main benefits of digital technology which are: that more pictures can be taken and stored or deleted, that payment for film processing is not necessary and pictures can easily be emailed to other people. There are numerous other technological advances as well.

However, this does not mean that a digital camera will give a better picture quality than a film camera. This is especially so in a dark environment. Digital photography has a number of drawbacks when compared with film and it has its own costs.

Photographing with a digital camera requires a different approach to obtain good results.

This seminar provided some simple approaches and some more complicated solutions both in photographic and computer techniques to the challenge that the digital world gives us in making great cave photographs. ■

WORKSHOP

DIGITAL IMAGING FOR CAVE PHOTOGRAPHY

Phil Maynard
7/11 Milson Rd Cremorne NSW 2090

WORKSHOP 1: BASIC TECHNIQUES

Digital cameras are rapidly gaining acceptance in photography. There are a host of new technologies and techniques associated with digital imaging. These include techniques that parallel traditional darkroom practices as well as completely novel techniques made possible by computerised storage.

This workshop covered the process of capturing an image, transferring it to a computer and performing basic enhancement techniques. Techniques relevant to cave photography were the focus of this workshop.

Topics covered included camera selection, camera resolution and storage, transfer of a digital image to a laptop, scanning film and slide images, file formats and image quality, image resolution on screen and in print, colour depth, colour saturation, colour balance, cropping/resizing/rotating images, and the use of levels and curves to correct mages.

Participants with their own laptops were encouraged to bring them and practice the techniques introduced in this workshop. ■

WORKSHOP 2: ADVANCED TECHNIQUES

This workshop covered more advanced image enhancement techniques for digital photography. Topics covered include layers and masks, selections, layer blending, use of the clone tool – techniques and ethics, blur filters, sharpening filters, novelty filters, and output options. Once again, the focus of this workshop was on techniques that are important for cave photography.

Participants with their own laptops were encouraged to bring them and practice the techniques introduced in this workshop. ■

PHOTO: GARY WHITBY

Pisa Chamber, Mammoth Cave, Jenolan Caves, NSW. (as in Leaning Tower of Pisa) Photo Competition Second Prize for a digital photograph in the Passages and Chambers category.

WORKSHOP

FINE TUNING YOUR SRT RIG

Alan Warild
41 Northwood St Newtown NSW 2042

INTRODUCTION

Almost all cavers have an SRT rig, and we all think that ours is the best. Rather than get involved in any arguments about what is and is not the best, I will just give a quick run down on what I use and why. There are also a few alternatives that I think are worth considering

DETAILS OF MY SRT RIG *(Figure 1)*

The emphasis of my rig is on simplicity and light weight, usability, efficiency and safety. It is not a rig for maximum speed up any one rope. In a deep cave, a simple, light, usable and efficient rig wins every time by saving me energy on climbs and time passing obstacles. This is a great way of improving my safety. There is a straightforward method for just about any rigging obstacle and I do not need to resort to gorilla tactics to make up for shortcomings in my SRT rig.

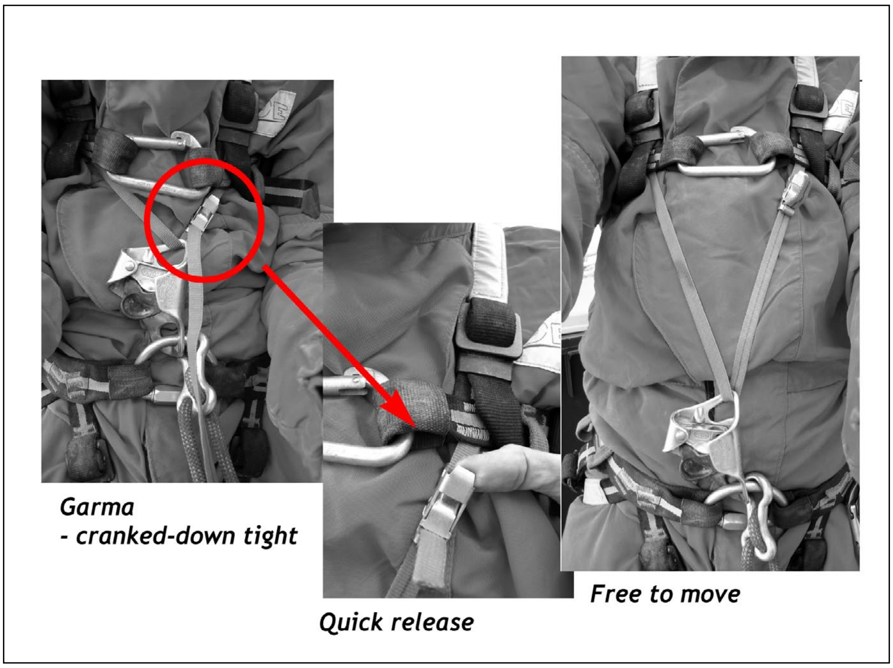


Figure 2

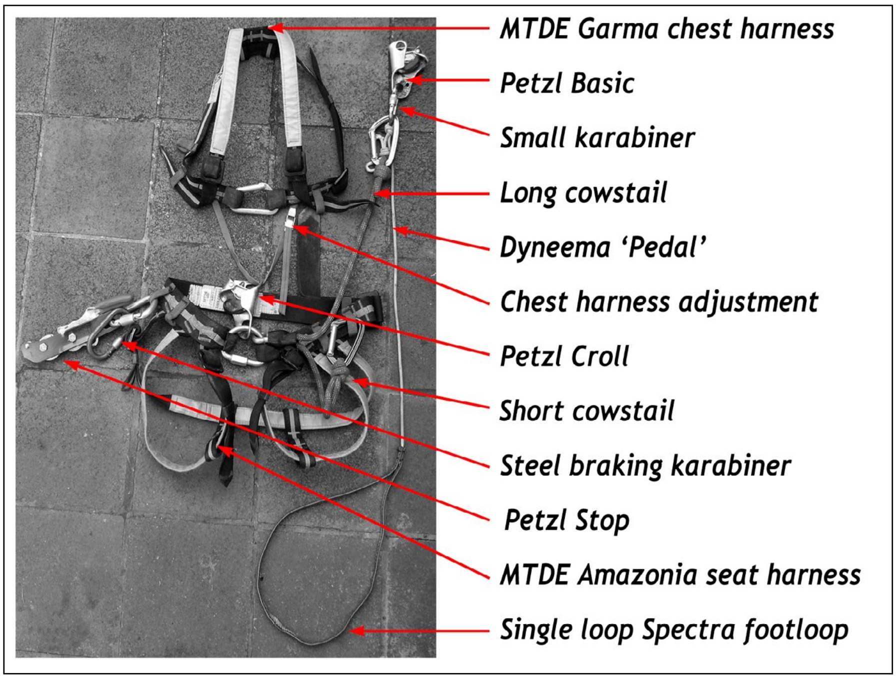


Figure 1

Seat Harness (Figure 2)

I use an MTDE Amazonia. It is light, exceptionally comfortable and has a very low attachment point.

Harnesses like the Petzl Superavanti are also good - they are just not as comfortable and their attachment point is not as low. No doubt there are other efficient harnesses out there in the market place. As long as the harness holds your main attachment maillon flat against your abdomen, your rig will work. However, you may lose efficiency and comfort. Whatever harness you decide to use, wear it as tight as you can get it.

Chest Harness

I use an MTDE Garma. It is a traditional 'bra style' chest harness with one important difference: it supports my Croll with an ingenious tape and bicycle toe-strap buckle arrangement. It is faster and easier to adjust than any other chest harness by a long way. It also has handy attachment loops from which to hang your goodies. If your major concern is to save money and weight, you still cannot beat a figure-8 harness with a krab that is fairly easy to release from a Croll.

Ascenders (Figure 3)

I prefer a Petzl Croll on my chest. A Bonatti copy would do. It's almost as good, possibly wears better, but is not quite as smooth to release or handle. For a hand ascender, I use a Petzl Basic for several reasons. It is small, compact, light, versatile and lasts well. It is also a comfortable shape to hold on to when I am climbing. I have not used a handle ascender for years. They are much bigger and a little heavier. The handle is useless when climbing a vertical

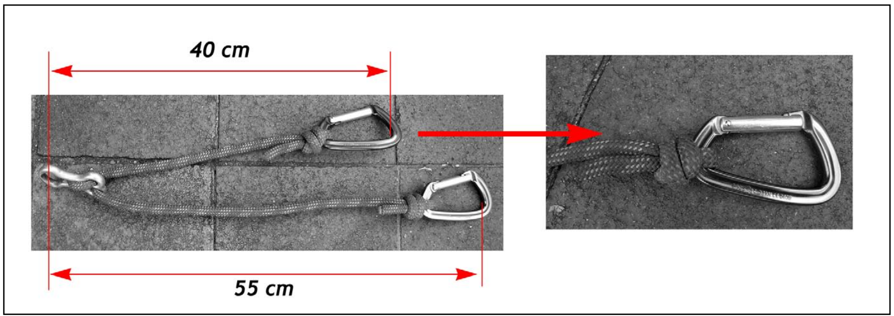


Figure 3

rope - but is nice to use on slopes and handlines.

When I push a handle ascender up the rope I tend to push the handle slightly to one side and this wears out the lower edge of the ascender's running surface. When I look at other people's handle ascenders from time to time, I do not think I am the only one with this problem.

Material for Cowstails

Mine is made of 9 mm dynamic rope. I use a double one with a cute metal eye at the bottom that I bought from Expe. It locks the rope without a knot so I do not have a bulky knot at my main maillon, or a knot that gets abraded. But the rope still does get abraded - which is one reason why I use rope instead of tape. When the sheath wears out I can change it. With tape I just cannot tell when it is worn out. Tape is not normally as dynamic either.

At the other ends I attach my cowstail karabiners. I use good quality, straight gated small non-locking D's - Petzl Spirit is good - in two different colours if I can get them. I put the pale one on my long cowstail. I attach the rope with half a double fisherman's knot (that is a half double fisherman's knot, not a single fisherman's!).

They are strong, neat and tighten onto the karabiner so I do not have to mess around with rubber bands or little metal bits to keep my cowstail tied to the correct end of its krab.

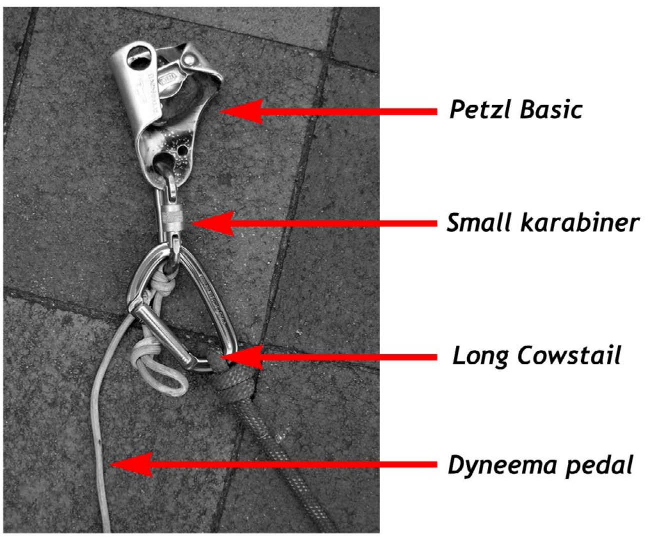
Length of Cowstails

My long cowstail also doubles as a safety for my hand ascender, so it is just long enough so that, when I push up that hand ascender, I have just enough rope, but no spare – if I am hanging from it, I still need to be able to reach it.

My short cowstail has grown a little over recent years as rigging styles have changed. It is just long enough so that I can use it for crossing rebelays on the way up, while not too long to prevent me from crossing them on the way down.

So, when I climb up to a rebelay and have both my ascenders as high as they will go without jamming them into the knot, I can just clip my short cowstail into the rebelay karabiner.

All that works out to an inside top of karabiner to maillon attachment eye distance of 55 cm for one and 40 cm for the other.



It's also quite reasonable to clip your cowstail into the Basic, then clip your pedal to that

Figure 4

Safety of Cowstails (Figure 4)

It is the cowstails that hold the whole thing together and provide much of the safety for my SRT rig. Long ago I got rid of the extra safety cord to my top ascender - it only got in the way, got tangled around things and was more weight and bulk to carry.

Whenever I was prussiking, my long cowstail was just hanging there doing nothing anyway, so I replaced it with a 'removable' safety, a.k.a. long cowstail. This of course means that I have to take care to always use it and not unclip it at the wrong time and accidentally trust my Croll as my only attachment point. Yes, it is physically possible to prussik the rope with no cowstail and the top ascender not attached at all. Would I do or recommend such a thing, even for a little pitch? - no! Get in the habit of always doing it right. Treat every pitch as a 100 m pitch.

Footloop/Legloop (Figure 5)

Perhaps the French-Spanish 'pedal' is a better word for this thing. Mine is made of 5.5 mm dyneema (also goes by the name 'Spectra'. Get it from MTDE or Expe), and is made specially for caving by Beal. It does not take a dye, so you buy it white and it becomes dirty white in no time. It has a real advantage that it wears and stretches like wire cable - that is, not at all. The lack of stretch makes for a more efficient stand motion. The lack of water absorption and bulk are unbeatable.

Unlike wire cable though, it is soft to touch, flexible and light. For the footloop itself I prefer a single large loop about 40 cm in circumference so I can get both feet in to hold the rope, and pop one or other foot out easily.

Get a spectra quickdraw of the length you like and tie an overhand loop around it with the end of the dyneema. If you have got tough feet, just tie a loop in the end of the dyneema, or alternatively, you can buy ready made pedals. Do not get an adjustable one, except perhaps for training people, just experiment a bit to get the length right. At the top of the pedal, I use a half double fisherman's knot to attach it to a small, life support karabiner.

I then clip my pedal to the bottomof my hand ascender. This way I can use the ascender and pedal together (normal

Figure 5

use) or as separate items on traverses and slopes where I may not want the pedal getting in the way. A variation on this is to clip your cowstail into your top ascender and your pedal into your cowstail karabiner.

Pedal length

My pedal is surprisingly short – 106 cm from the bottom of the footloop to the attachment eye of my ascender. When I put both feet in the loop and stand up straight, the ascender barely reaches the bottom of my Croll. However, once I am hanging on a rope, my pedal is short enough so that when I push my hand ascender up as far as I can reach, my feet cannot come up any further anyway, and of course, my cowstail is just about to pull tight. If I take out one foot, I can step higher and reach higher, but I have less power climbing with one leg. When I stand as high as I can with both feet in the loop of the pedal my Croll almost hits my hand ascender.

The bodies of the ascenders do overlap, but the wrap around sections do not actually touch. To get the pedal length right, just shorten it bit by bit until your ascenders touch, then lengthen it a little.

Descender

Zipping down a rope on a non-stop descender is like riding a bicycle without brakes...

I use a Petzl Stop. I attach it with a locking karabiner. No need for any fancy twist-lock, rapid on-off mechanisms. I also always use a steel braking karabiner. Steel may be heavy, but anything else wears out rapidly, even Russian titanium karabiners. I picked up two really nice steel ovals with smooth pin and slot latches on the gate, which makes them really user-friendly. Most steel krabs, if you can get them, have really nasty claw latches and there is only so much you can do with a file. If you cannot get steel, or titanium, you may have enough aluminium karabiners to grind to dust.

Try to find a Raumer 'Handy', a special stainless karabiner-like 'brake-krab' which should last you forever. As a rule my ascender is either on my seat maillon for descending or on my belt/harness loop in an easy to get position when I am ascending.

Just as my 'up' gear goes down a cave attached to me and ready to go, my Stop is always handy when I am climbing and never in a pack that may get left behind or carried-off by someone else.

Foot Ascenders/Pantin

European cavers have discovered the foot ascender. Ask any French caver and he will tell you that the Pantin is 'zee best'.

A Pantin pulls the rope tight for your Croll so that you can effectively prussik up a tight rope.

It also allows you to use a walking motion on slopes, and if you are a gorilla, on freehangs as well. It may also save you some energy and certainly make you feel like you are climbing better, but there is a price.

Your Croll will wear out perhaps twice as fast, and you have a third ascender to attach to the rope, which you usually have to put on a few metres up as they do not necessarily run right from the bottom.

There is no need to wear your Pantin all the way down the cave. You do not 'need' it in order to climb.

What I have described is SRT gear that works for me. Everyone is a different height, has different proportions and different flexibility, so you may need to set up your equipment slightly differently.

Having said all that, none of this gear, or the techniques for using it, are foolproof and things can go wrong.

If you don't like it, or don't feel safe, don't do it!

Places to look for those special goodies that you cannot buy just anywhere at the following web sites: www.mtde.net, www.expe.fr ■

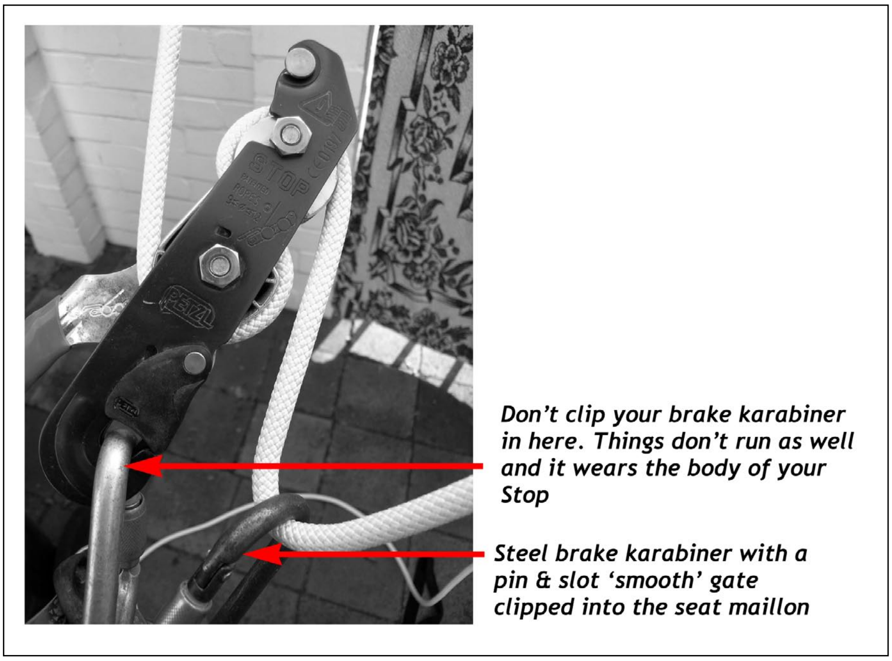


Figure 6

FOURTH INTERNATIONAL CAVE ART EXHIBITION
DOVER, TASMANIA

June MacLucas
11 Gulfview Pde Valley View SA 5093

PHOTO: JULIA JAMES

June MacLucas in front of some of the displayed artwork.

In 1993 – while on holiday in the UK – June MacLucas met an English cave artist, Robin Gray, during a visit to the caving area of Cheddar. Robin talked about starting a Speleo Art Club and asked whether June would be interested… and shortly after in 1994, he became one of the founders of the International Society for Speleological Art (ISSA). June has been a member of ISSA ever since and being mindful of the successful speleological art exhibitions that had taken place in Britain, Europe and America under the auspices of ISSA, she was keen to see a similar event occurring here in Australia.

In September 1998, June approached Peter Berrill, in his role as president of the Australian Speleological Federation (ASF) and convenor/organiser of the 22nd ASF Conference at Yeppoon near Rockhampton, to see whether ASF would be interested in hosting an International Speleological Art Exhibition as part of the January 1999 Conference. As convenor of this particular conference, Peter was very receptive to the idea and encouraged June to go ahead and make all the necessary arrangements.

As a member of ISSA, June incorporated their criteria and guidelines for cave art exhibitions encouraging Australian and overseas artists to take part and exhibit their work during the ASF biennial conference at Yeppoon and following on… at the last three successive biennial conferences. During the 3rd Cave Art Exhibition held at Bunbury in Western Australia, John Dunkley – then President of ASF – expressed his interest in making the exhibition a regular feature of the Conference. This is now our 4th International Cave Art Exhibition and with each exhibition the interest on the home front has grown. Hopefully it will continue to expand, encouraging cavers to express their own experiences through an art form.

Speleological art is only one small facet of caving, but think about it, cave art has been around for some 40,000 or more years, especially here in Australia. From the perspective of an Aboriginal person, cave art takes on quite a different meaning. It expresses the rituals of hunting, ceremonial activities and sacred iconography as well as giving a presence of having been there in the form of hand stencils. This sense of being there is also applicable to modern day cave artists, especially when the speleo artwork is commenced and/or completed in a cave. The artist experiences the acts of caving and seeing the wonder of the subterranean landscape mostly unseen by people outside caving groups. Believe me, working directly underground on one's own artwork can be exciting and daunting, at the same time offering challenges rarely experienced by a landscape artist.

These speleological art exhibitions are important. Visual artwork has been around much longer than photography and it can reveal the emotions of the artist and in this aspect, the emotions and feelings of cave artists. Such exhibitions offer a chance for speleo artists to exhibit their work to a group of people who share their love of caving and to bring to the general public an awareness of this awesome and inspiring landscape existing beneath the surface.

This time around, the 25th ASF Biennial Conference offered – for the first time – a chance to have the exhibition in an established art gallery at the Old Dover School, where the display continued for the duration of the conference. You could see that the Dover Art Gallery had in fact been an old school classroom and although the gallery space was small, we managed to exhibit 89 pieces of work contributed by 14 artists: including three cavers from overseas, plus five from around Australia and six local artists from Dover. The art work included oil paintings, watercolour, pastels, drawings and sculpture that either arrived through the post - or was delivered by cavers themselves. Other exhibits from local artists consisted of jewellery, embroidery, photography and a


PHOTO: ARTHUR CLARKE

John Dunkley introducing guest speaker Adrienne Eberhard at the opening of the Australian Speleological Federation 4th International Cave Art Exhibition on 3rd January 2005.

video. Unfortunately, art works by Eve Taylor, although listed, did not arrive in time for the exhibition. This is not the first time that artwork has arrived too late for an exhibition. Disappointed artists should be aware and try to ensure that the work arrives before the due date. One way to do this would be to pass it on to a caver who is attending the conference.

Unfortunately, although exhibiting at a gallery was an exciting prospect for the artists involved, it did pose a problem, because the gallery was situated about ten minutes walk away from the conference venue which itself was also a considerable distance by bus from the main accommodation site. Hence, it made it difficult for cavers attending the conference to just browse through the art work between lectures and at lunch time. Nevertheless, from this collection of work, the exhibition sold 19 pieces in five days, from Monday afternoon to Saturday, the full duration of the exhibition. Given these circumstances – at a location remote to the conference site – it is pleasing that the sales were greater than first expected!

Throughout the exhibition there were many highlights… from an outstanding and exciting opening attended by everyone at the conference, to a personal preview of the art work by the Governor of Tasmania and his wife, the Hon William J E Cox and Mrs Cox, who were accompanied by their aide-de-camp, Steve de Haan. His Excellency viewed all the art work making a comment that although he admired our tenacity, unfortunately caving was not for him.

A few hours after the Governor's preview, the 4th international speleological art exhibition was opened by an accomplished Tasmanian poet, Adrienne Eberhard, who delivered an interesting and inspirational reading from her own work. Jenny Robson, a guide from Hastings Caves enthralled us with a wonderful rendition of a locally composed song that related the epic construction of the pioneer road to Hastings Cave during the depression years. I am very grateful to local artist Robyn Claire who prepared and donated a wonderful spread of sweet delights with meringues, fruit cake and Greek baklava, along with cherries from the local orchard of Bruce Morrisby and a varied selection of pizza from the nearby wood-fired pizza restaurant… all wonderful to the palate. In addition to the stubbies of Pale Ale donated by Cascade Brewery, there was a varied selection of wines on offer including the special CaveMania 2005 Limestone Coast wines, plus some fruit and flower wines from the local Bates Creek Winery.

After the opening, there were over thirty cavers still in "party" mode who socialised over dinner at the Dover Wood-Fired Pizza Restaurant - situated next door to the Dover Gallery. There were more fruit wines on offer, donated by Robyn Claire and Arthur Clarke.

The exhibition was staffed on a roster basis throughout the duration of the conference by Robyn Claire, Brent Fraser, Julia James, Grace Matts, Rhonwen Pierce, Jodie Rutledge, Meryl Moscrop, Howard Whitehead, and June and George MacLucas.

Special thanks must go to these people and also to local members of Far South Regional Arts for their help and support, especially for their help on the evening of the exhibition opening: therefore, many thanks to Jane Thiele, Caroline Amos, Wren Fraser Cameron, Denise Young, Howard Whitehead and his daughter and all who helped to make the opening a great success. Special thanks must also go to Steve Bunton and Arthur Clarke, especially Arthur for his tireless contributions to the organisation of the exhibition. Thanks Arthur.

ARTISTS REPRESENTED AT THE EXHIBITION

BALISTER, Rosemary	Charlottesville, USA
BUNTON, Stephen	Hobart, Tasmania
CLAIRE, Robyn	Dover, Tasmania
CLARKE, Arthur	Dover, Tasmania
FRASER, Brent	Dover, Tasmania
CHANDLER, Ian Ellis	Spain
GRAY, Robin	Cheddar, Great Britain
LARKIN, Brigid	Mount Gambier, South Australia
MacLUCAS, June	Adelaide, South Australia
MOSCROP, Meryl	Strathblane, Tasmania
TAYLOR, Eve	Quinns Rocks, Western Australia
THOMPSON, Coral	Australind, Western Australia
WHITEHEAD, Howard	Surveyors Bay, Tasmania
WINNING, Margorie	Victoria Point, Queensland

Earth, Air, Water, Fire

(A Love Poem in Four Elements)
by Adrienne Eberhard

Read by the author at the Artshow Opening

1. Earth
We carry caves inside us:
the heart's dark chambers,
water-washed cavern of the womb,
limestone pockets of the brain.
When our boy digs himself a mouse hole
and upends himself, hat and all, is he
trying to re-enter his own body, or mine?
There are no real boundaries: this osmosis
of skin, layering of rock on rock - Permian,
Cambrian - tilt and seismic shift of the heart.
Watch our children here. See then beguiled
by the slow, infinite drip of water
with its luminous light making moon-milk,
mother's milk, the breast-like beginning
of a stalagmite that our boy names *scrimbal,*
the tapering stillness of straws, articulate
as fingers, distant as stars, the thick-bodied
pillars like muscled torsos connecting
floor and ceiling, earth and sky.
We are all mythic creatures.
Our children delight in small fragments of stalactite,
broken pieces like statuary they can pocket
or caress, as if the cold stone casts them
in marble, linking them with the ancient past.
If they could they would *take, eat,*
consuming the labours of millennia,
calcium carbonate bubbling in their blood,
quickening their limbs to the silent flight
of angels, gods. This accretion of coral reefs,
the compacting of dirt, soil, stone,
the percolation of time and water
is our story too. Love begins in caves,
maps its territory with echo location,
spreads velvet wings in the tiniest passages,
then unfolds across desert sands
with the moon an enormous pearl
rising behind a thousand wing-beats.
Bear witness to it here, where our boys race
the translucent stone; trace love's growth
in rock rings, its steady pulse in the unearthly
blue light of glow-worms
starring the dark.

First published in *Island 98,* Spring 2004 and reproduced with the permission of the author.

The Hastings Roadway

Sung by Jenny Robson at the opening of the artshow.

1. In nineteen hundred and thirty-five
We needed jobs to stay alive.
We packed our bags and headed off,
To work the Hastings Cave Road
2. They gave us all a mattock and spade,
With a barrow or two through the mud we'd wade,
Pushing rocks, knee deep in mud,
To work the Hastings roadway
Chorus
Fillie me oorie oorie ay
Fillie me oorie oorie ay (sung three times)
3. Winter 37 was wet and cold,
Our shoes fell apart, but we were bold.
We asked for boots but were booted instead.
No work on the Hastings roadway.
4. The scrub was thick and the work was hard.
We struggled and fought it yard by yard.
A man was killed and we'll not forget,
The work on the Hastings roadway.
Chorus
5. A frosty winter thirty–eight,
For a month the frosts did not abate.
But the trucks rolled better on frozen mud.
At work on the Hastings roadway.
6. In nineteen hundred and thirty – nine,
I looked back and the pride was mine.
Six long miles and four years graft.
At work on the Hastings roadway.
Chorus
7. So when you drive to the cave today
Think of the men on a pittance of pay
Who made it easy for you to drive,
To drive the Hastings roadway.

Lyrics adapted by Paddy Prosser from notes taken by Arthur Clarke, in conversation with Handy Jager. The song has been recorded on CD by The Southerly Busters and is available from the Hastings Caves Visitors Centre.

SPELEOSPORTS

Stephen Bunton

PHOTO: JULIA JAMES

Speleosports winners (L to R) Matt Cracknell, Dane Evans, Rhys Evans and Grace Bunton (front).

Host club Southern Tasmanian Caverneers is only small and with limited manpower available to organise the Conference, it looked as though it would not be possible to stage Speleosports as part of CaveMania. Speleosports is a very cherished tradition at all ASF Biennial Conferences and there was nearly outrage when it looked like not being included in the programme. As a result Greg Thomas offered the expertise of the West Australians, gained as hosts at the last ASF conference UnderWAy.

Greg and his team of Darren Brooks, Ian Colette and John Cugley, took just one look at the top playground behind Dover District High School and in a short morning transformed it into a series of imaginative cave obstacles. There was a rope course across the swings, a sandpit maze-squeeze beneath a sheet of black polythene, left over from the blacking-out of the auditorium. The black plastic also proved useful to wrap sections of the playground's climbing frame to make it very cave like. Spaghetti straws were added for greater realism. The final obstacle was a flattener through the playground's old rowboat, which when lined with plastic ensured a nice deep puddle to wet the knees and elbows. The flattener also contained a few helictites to slow people down and ensure they showed respect for the cave environment. Touching or breaking straws or helictites incurred time penalties. Each of the four team members also carried one egg which had to be carried the whole way and could not be put on the ground. Considerable time penalties were incurred for dropping and breaking the egg.

PHOTO: GARRY K SMITH

Speleosports girls (L to R) Jay Anderson, Cathie Plowman, Jessica Wools-Cobb and Janice March .

The West Australians then undertook the course as a demonstration team. They came very close to posting the fastest time of 6 minutes 30 seconds with no time penalties, until the "Ferals", an STC team, of Matt Cracknell, Grace Bunton, Dane Evans and Rhys Evans eclipsed them with a time of 5 minutes 37 seconds including a 30 second time penalty for touching a straw. Eight teams competed in the event including a very fashionable all female team . It must be noted that the teams that performed best in this event were those who had perfected their teamwork.

PHOTO: GARRY K SMITH

Negotiating the ropes course.

CaveMania Speleosports was certainly a great success, despite being held under conditions of intermittent rain and drizzle, which added just that little bit of authenticity to the Tasmanian caving experience. On behalf of everyone I would like to extend my thanks to the organisers and judges for their efforts. ■


PHOTO: GARRY K SMITH

The sandpit maze-squeeze.

PHOTO: GARRY K SMITH

The final obstacle – the wet rowboat flattener.

PRUSIKING RACE

MEN

Placing	Entrant	Time
1st	Greg Thomas	1:48
2nd	Darren Brooks	2:21
3rd	Gerrard Collins	2:22
4th	Al Warild	2:36
5th	Matt Fischer	2:40.5
6th	Gary Whitby	2:41
7th	Yoav Barr-Ness	2:45
8th	Paul Brooker	2.56
9th	Tim Moulds	3.06
10th	Reto Zollinger	3.11
11th	Michael Bates	3.29
12th	Alan Caton	3.37
13th	Ian McCulloch	3.43
14th	Ken Hosking	3.47
15th	Ian Binnie	4.34
16th	Michael Wasmund	4.42
17th	David Wools-C0bb	4.44
18th	Jason Cockayne	5.31
19th	Henry Shannon	5.39
20th	Saeid Hakimi Asiabar	6.30
21st	Miles Pierce	11.26

WOMEN

1st	Matilda Thomas	3:07
2nd	Jenny Whitby	4:07
3rd	Janice March	4:16
4th	Amy Ware	4.50
5th	Vicki Bresnan	6.08
6th	Jessica Wools-Cobb	6.23

PRUSIK LOOPS DEMONSTRATION

Garry K. Smith	7.03

ROPEWALK DEMONSTRATION

Tom Porritt	1.51

OVER 60s (THOSE WHO DECLARED IT!)

1st	Vicki Bresnan	6:08
2nd	Miles Pierce	11:26

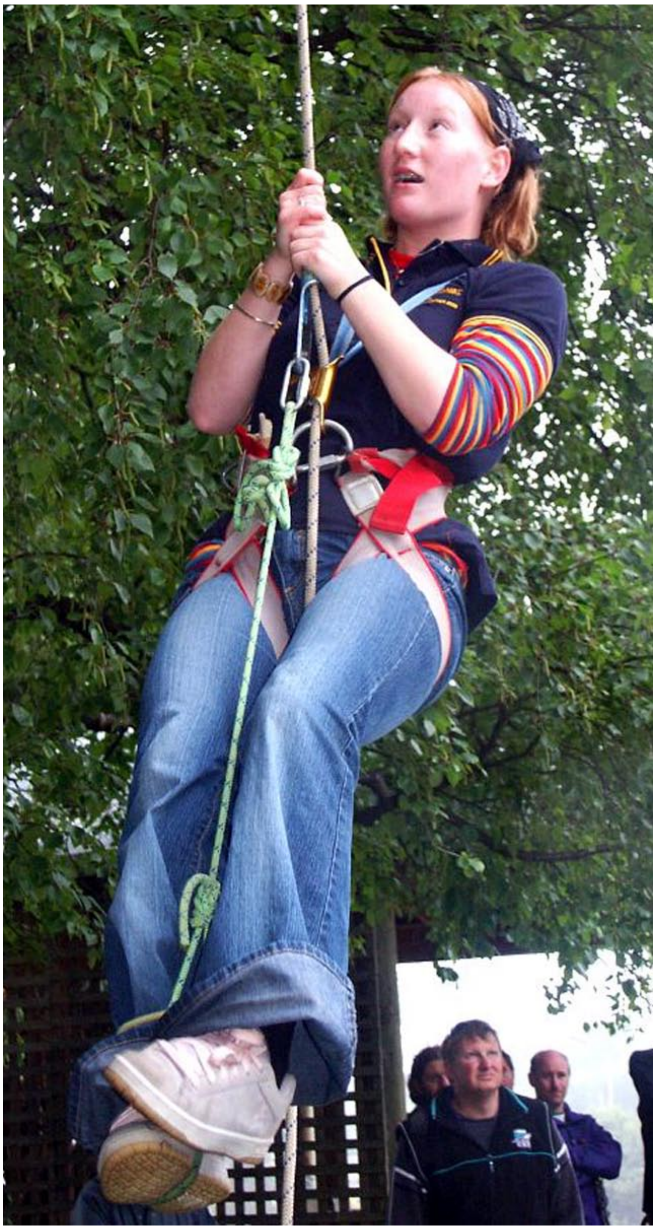


PHOTO: GARRY K SMITH

Jessica Wools-Cobb in action.

CAVEMANIACS' DINNER

Stephen Bunton

Attendees at CaveMania were informally referred to as Cave Maniacs. At previous conferences there have been Caveman's Dinners but Cave Maniac is a more gender inclusive term which also indicates the real degree of obsession with our principal pastime. While caving is our first passion, eating, drinking and socialising run a close second. The official conference dinner provided just a great opportunity to indulge those other passions.

The only venue in Dover that was capable of seating all the 106 CaveMania participants was the Dover RSL Club. The RSL Club's Ladies' Auxiliary catered for the event and it was by far their largest undertaking to date. A slight mix-up concerning the time the dinner was supposed to start caused more than a little anxiety over keeping the food warm and precipitated a rather hurried start to the evening's proceedings. In the end nobody minded, the meat was wonderfully tender. By the time we had completed the evening's proceedings it was midnight and for some cavers even later.

The quaint old-world charm of the Besser block building with its wonderful view over the bay was appreciated by everyone. We dined as the sun set over Adamsons Peak watching the play of rain showers which saw it periodically wrapped in cloud. At 9 pm we observed a minute silence as is customary in all RSL clubs. The evening included the drawing of a raffle sponsored by Cadbury-Schweppes which raised $144.00 for ASF. First prize was a hamper of chocolates won by John Taylor. Second prize was a box of favourites won by Steve Blanden.

Earlier in the Conference the Tsunami raffle had raised $361.00. First prize was donated by Ian and Jenny Ferrier of Mountain Designs, Launceston. It was a Petzl head torch which was won by Ian McCulloch. Other prizes were a selection of Tasmanian cheeses, chocolates and wines which were won by Joe Sydney, Dorothy Robinson and Serena Benjamin.


PHOTO: JOE SYDNEY

Stephen Bunton presenting Arthur Clarke with his Photo Competition certificates.

The prizes for the winners of the Photo Competition, the Speleosports and the Prusik Race were also presented.

The main entertainment of the evening was an auction for the ASF EnviroFund. This was arranged by Joe Sydney, who was a brilliant success as the auctioneer. Prizes were donated from a range of sources and raised a total of $1426.20. The formal part of the evening was the presentation of the ASF Awards by John Dunkley and it was one of his last official duties as ASF President.

ASF AWARDS 2005

John Dunkley

Every two years the ASF announces awards to individuals who have made a significant contribution to any field of speleology. The 2005 Awards were announced at the CaveMania Conference Dinner at Dover.

Nominations were received by the Chairman of the Awards Commission, Lloyd Robinson, and considered by a selection committee chaired by the President of the day (John Dunkley) and including at least two other past Presidents.

The selection committee is very much dependent on clubs and individuals to nominate worthy recipients. The process is competitive: this year 17 nominations were received from clubs and several individuals, and nine awards were made. Within each category the recipients are listed alphabetically in no particular order of merit. A full list of award winners from 1972 to 1999 appears in *Australian Caver* 152, with updates in *Australian Caver* 154 (which also has a lengthy article on Edie Smith and the award named after her) and 158.

EDIE SMITH AWARD

Instituted in 1972, the Edie Smith Award commemorates one of Australia's pioneering cavers and the first woman President of an Australian speleological society. It recognises outstanding achievement over a long period of time. In 2005 we celebrate two people who have made outstanding contributions to Australian speleology as well as putting Australia on the world caving map.

ARTHUR CLARKE

The Award recognises Arthur's outstanding achievement in numerous aspects of speleology, including exploration, surveying, meticulous documentation, publication, photography and biospeleological research.

Arthur is a real speleological polymath. After starting caving in the 1960s with UQSS and VSA, he helped found the Tasmanian Cave and Karst Research Group, was founding President of Southern Tasmanian Caverneers, and was a former Vice-President of ASF and Executive Member of ACKMA. An indefatigable explorer, his feats include numerous hard exploratory and surveying trips in the Ida Bay (especially Exit Cave), Hastings and nearby karsts particularly. He is Tasmanian Coordinator for the ASF Karst Index Database, a veteran of major international expeditions to China and Madagascar where expertise in both caving and scientific research was essential, and is an internationally recognised authority on some obscure cave biota, some of which bear his name in accordance with scientific practice. Having spent 15 years exploring and documenting the Ida Bay karst, Arthur played a leading role in working towards World Heritage listing for Exit Cave and subsequent closure of Benders Quarry and later in opposing exploration licences at Mt Cripps. Arthur is joint author of a forthcoming book on the history of cave tourism in Tasmania. He is also a manufacturer of prize-winning fruit wines that were sampled by many Conference attendees. A resident of both Hobart and Dover (where he moved to be close to the caves!), Arthur has been an unfailingly generous host to numerous visiting cavers from interstate and overseas. Somewhere among all this, Arthur finds time to pursue MSc studies in biospeleology and to advise the Tasmanian government on related issues.

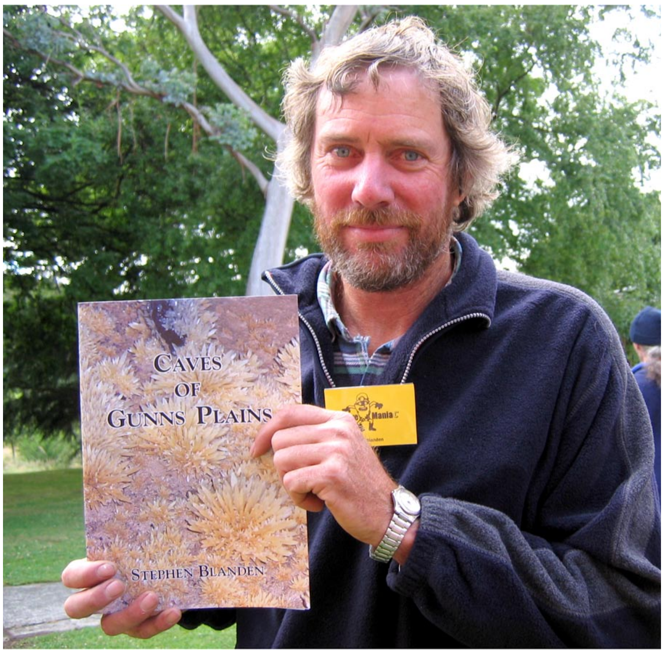


PHOTO: JODIE RUTLEDGE

ASF Merit Certificate recipient Steve Blanden and his book.

AL WARILD

The Award is given for outstanding achievement in exploration and surveying of the world's deepest caves, for development of technical equipment and techniques, and for being a flag-bearer for Australian caving throughout the world.

Al started caving in the 1960s, with a Wee Jasper trip in 1968 and trips to Bungonia over the next six years. He started 'real' SRT in Tasmania in 1975, then joined expeditions to New Zealand in 1976 and began alpine cave prospecting in Nettlebed Cave in 1982/83. Interest in Mexico began in 1977, and Papua - New Guinea in 1978. Al has also made numerous return trips to Mexico including the first exploration of a -1,000 m+ cave by an Australian expedition. Eventually he was sufficiently well-known as a vertical caver to be found a place on expeditions to remote high limestone mountains in often obscure countries, from Patagonia to Georgia, Vietnam and Slovenia. Al developed and pioneered a number of techniques for exploration of deep caves, including solo exploits, and has bottomed 16 caves greater than 1,000 m deep throughout the world, including solos to -1,122 m in Gouffre Berger, -1,535 m in Reseau Jean Bernard, -1,159 m in Gouffre de las Bracas du Thurugne, -1,149 m in Pozo del Jitu, and -1,180 m in Sistema Arañonera. We understand that he has since outgrown solo exploits! However the challenge continues, as he has shown by joining recent expeditions to Voronia Cave in Abkhazia where he set a new world depth record (see *Australian Caver* 161 & 163), that drew attention from the mainstream press. Finally, Al is the author of *Vertical*, the world's bible of vertical caving.

ASF AWARD OF DISTINCTION

The ASF Award of Distinction recognises excellence in several fields of speleology. This is the first time this award has been given "for excellence and achievement in cave exploration and documentation". This award is given jointly to John and Glenda Wylie, particularly for exceptional achievement in exploration, documentation and publication of caves at Wombeyan, NSW, as exemplified in the recently published Wombeyan book. Although best known for their exploits at Wombeyan, John and Glenda have been active cavers for over 25 years, starting with Venturer Scouts and including exploration and documentation in Mt Cripps (Tas), Lord Howe Island, Macleay Valley, Billys Creek (NSW) and in Thailand. John and Glenda are individual members of ASF and members of SSS.

ASF CERTIFICATE OF MERIT

Stephen Blanden

Stephen is a member of Savage River Caving Club and the award celebrates his tremendous enthusiasm and tireless efforts in the discovery, surveying and documentation of caves and karst features in northern Tasmania, especially Mt Cripps, Gunns Plains and Mole Creek, culminating in the recent self-publication of *Caves of Gunns Plains.*

Louise Coleborn

A member of Blue Mountains Speleological Club for 29 years, Louise has held virtually every office except that of President. She was ASF delegate for 10 years, a key surveyor of the complex Taplow Maze at Cliefden and is currently doing a thorough documentation of Aboriginal cave sites in New South Wales.

Rob Foulds

Rob is a member of both WASG (of which he was President in 1996/97) and SRGWA. A self-taught enthusiast, Rob became interested in subterranean fauna, particularly spiders in the Leeuwin-Naturaliste area, and now volunteers about 160 hours a year at Yanchep, conducting a systematic study of cave biota, and ecological work on hydrology, variations in groundwater levels and its effect on cave animals.

Penny Janson

Penny is a member of Rover Speleological Society, of which she has been a leading organiser for many years. She was a key mover in developing the club's training program and for 14 years as a member of the club she ran Guide and Ranger Guide weekend camps typically for 20 – 30 girls at a time, introducing young people to safe and ethical caving.

John Kersey

John began caving in Queensland in 1969 and discovered Queenslander, the state's longest cave. He founded and for 20 years or so has run a small, mainly family-oriented group from Townsville and Charters Towers. The group discovered, tagged and documented especially the Broken River area over many years. In the process he developed excellent relations with the landowner to improve knowledge of the area among speleologists.

Bob Kershaw

Bob is a member of Illawarra Speleological Society, noted as an insatiable explorer and a dedicated and meticulous planner and recorder. Bob made major contributions to organisation of expeditions to South-east NSW, the Nullarbor and Gregory National Park (NT), and is the Operations Manager for the Gregory Expeditions and a mainstay of the survey of Bullita Cave, Australia's longest. Bob is also a sometime trainer in caving and abseiling for the Scouting Association and a highly regarded authority on search and rescue throughout the State Emergency Service. ■

PHOTO COMPETITION AWARDS

1: CAVE ENTRANCES/ OTHER SURFACE KARST FEATURES

Print

1st	Brent Fraser	Ice Cave Entrance, Pryde Bay, Antarctica (see page 49)
2nd	Andrew Bosman	Contemplation
3rd	Arthur Clarke	Reflected entrance of Nuiping Dong, SW China

Slide

1st	Norm Poulter	Talia Sea Cave, SA
2nd	Mick Williams	Chillagoe Karst
3rd	Norm Poulter	Stockyard Gully Tunnel, WA

Digital

1st	Ross Anderson	Window Cave
2nd	Arthur Clarke	View towards Belvedere (Tsingy de Bemaraha, western Madagascar) (see page 32)
3rd	Ross Anderson	Wanderers One

2: PASSAGES/ CHAMBERS

Print

1st	Garry K. Smith	Kubla Khan: Pleasure Dome (see page 29)
2nd	Andrew Bosman	Scallops
3rd	Arthur Clarke	Side passage in Mystery Creek Cave

Slide

1st	Norm Poulter	White Chamber, Ngilgi Cave, WA
2nd	Norm Poulter	Old Kudarup Cave, WA
3rd	Norm Poulter	Phreatic Passage, Nurina Cave, WA

Digital

1st	Garry K. Smith	Reflections - Croesus Cave
2nd	Gary Whitby	Pisa Chamber (see page 98)
3rd	Gary Whitby	Lava Tongue Passage (see back cover)

3: CAVE DECORATION/ FORMATIONS/DEPOSITS

(includes speleogens, petromorphs, speleothems, bone deposits and clastic fills)

Print

1st	Arthur Clarke	Kubla Khan stalactites and straws
2nd	Arthur Clarke	Bladed shawls with dogtooth spar in Riveaux Cave
3rd	Dirk Stoffels	Dogleg Helictite

Slide

1st	Norm Poulter	Halite Filigree, Mullamullang Cave, WA
2nd	Norm Poulter	The Pendulum (The Ball) Ballroom, Exit Cave, TAS
3rd	Norm Poulter	Straw Reflections, Weelawadji Cave, WA

Digital

1st	Gary Whitby	(Big) Mothers of Pearls (see page 59)
2nd	Gary Whitby	The Mother Lode
3rd	David Wools-Cobb	Crystal Tree (see page 61)

4: SCIENTIFIC

(cave conservation/research/dye-tracing/cave life or biology)

Print

1st	Arthur Clarke	Fungivorid mycetophiloid gnat on agaric fungus in cave at North Lune, Tasmania. (see page 10)
2nd	Athur Clarke	Cave adapted Anaspides at Mole Creek (see page 10)
3rd	Arthur Clarke	Cave biologist with opilionid *(Ischyropsalis sp.)* in Grotte de Laspugues, southern France

Slide

1st	Norm Poulter	Male Tartarus Spider climbing his web
2nd	Norm Poulter	Bat Skeleton, "I must stop this diet!"
3rd	Mick Williams	Calcified blowfly in Berks Frontyard (at Gregory in Northern Territory)

Digital

1st	Garry K. Smith	Undescribed species of Trapdoor Spider at Pilchers Cave
2nd	Garry K. Smith	Shell Fossil at Caves Flat
3rd	Garry K. Smith	Bentwing Bat, Glenrock Caves (see page 13)

PHOTO: MICHAEL RUTLEDGE

Photographer of the Year, Garry K. Smith, at work in Croesus Cave.

5: CAVERS IN ACTION

(Humorous/technique/surveying/historical)

Print

1st	Dirk Stoffels	A Caving Photo
2nd	Miles Pierce	Ken Boland - First entry into Whispering Cavern (6N2953)
3rd	Andrew Bosman	Try Harder, John

Slide

1st	Mick Williams	Cavers in Croesus Cave (at Mole Creek)
2nd	Mick Williams	The Snake's Witness in Wishing Well Cave (at Undara Lava Tubes)
3rd	Mick Williams	Caver (Arthur Clarke) outside Mini-Martin (at Ida Bay)

Digital

1st	Al Warild	Marta Luz
2nd	Ignacio (Nacho) Rafael	Tyrolean Traverse (similar to front cover)
3rd	Garry K. Smith	Paul in Haillie Selassie Cave (see page 111)

CURIOUS AND HUMOUR

1st	Garry K. Smith	Headless Caver
2nd	Gary Whitby	Monty Python Strikes Again

First place getters received a bottle of wine or a six pack of Cascade Pale Ale.

PEOPLE'S CHOICE

Steve Blanden	Calcite Flower: dogtooth spar from Emperor Cave, Gunns Plains ($50 voucher from Mountain Designs)

AUSTRALIAN CAVE PHOTOGRAPHER OF THE YEAR

Garry K. Smith	($100 cheque from Walch Optical)

RUNNER UP FOR THE AUSTRALIAN CAVE PHOTOGRAPHER OF THE YEAR

Arthur Clarke	($50 voucher from Mountain Designs)

CAVEMANIA FIELDTRIPS

Stephen Bunton

Events
Tasmania
www.eventstasmania.com

CaveMania Fieldtrips 2005 was supported by the Tasmanian Government through *Events* Tasmania.

The caving areas of southern Tasmania at Hastings and Ida Bay are readily accessible from Dover and this was one of the main reasons for holding CaveMania in this regional centre. Throughout the conference many people visited Newdegate (Hastings Tourist) Cave taking advantage of the free tours offered by The Hastings Experience. The Hastings Experience also provided the leaders for the main fieldtrips day, Wednesday 5th January. Participants were ferried back and forth to Mystery Creek Cave or King George V Cave before everyone met for an evening BBQ at Hastings Thermal Pool.

The celebratory mood obviously affected Hastings Cave Manager, Keith Vanderstaay, who offered a special more personalised late-night tour of Newdegate Cave. This was extremely popular with quite a crowd taking him up on his generous offer. At various times throughout the conference people made their own arrangements, some of them joining caving trips run by Southern Tasmanian Caverneers. Several trips were run through Midnight Hole into Mystery Creek Cave. Southern Tasmanian Caverneers also ran post-conference fieldtrips from the Southport Hall. Exit Cave was the main drawcard and a small percentage of CaveMania participants were able to visit this cave.

Permits were also issued for Mini-Martin and Old Ditch Row which are vertical entrances into the Exit Cave system. Some original exploration, surface and underground surveying was undertaken while Arthur Clarke arranged some fieldtrips for the visiting biologists, some specifically as part of Dave Merrit and Glenn Graham's glow-worm research.

On Saturday 15th January, Aardvark Adventures hosted 14 cavers on an abseil of the 142 m face of the Gordon Dam. This is one of the world's longest commercial abseils and a highlight for many participants.

Over the following week a few more fieldtrips were run in the Junee-Florentine area including trips into Growling Swallet as well as a Slaughterhouse-Growling Swallet through trip. A tour of the Florentine Valley and some commentary on the issues of karst management was also undertaken as a follow up to Kevin Kiernan's paper at the Conference.

At Mole Creek an enthusiastic group of local leaders guided a plethora of visiting cavers through the main caves of the area. The centrepiece of these fieldtrips was the Karstcare cleaning program in Kubla Khan Cave facilitated by Dave Wools-Cobb of the Northern Caverneering Club. Permits were also issued for the areas's other iconic caves with people taking the opportunity to visit Croesus Cave, Lynds Cave, Genghis Khan, Baldocks Cave and many others. ■

PHOTO: CHRIS HERBERT

Kathy Bunton on the 50m introductory abseil of the Gordon Dam.

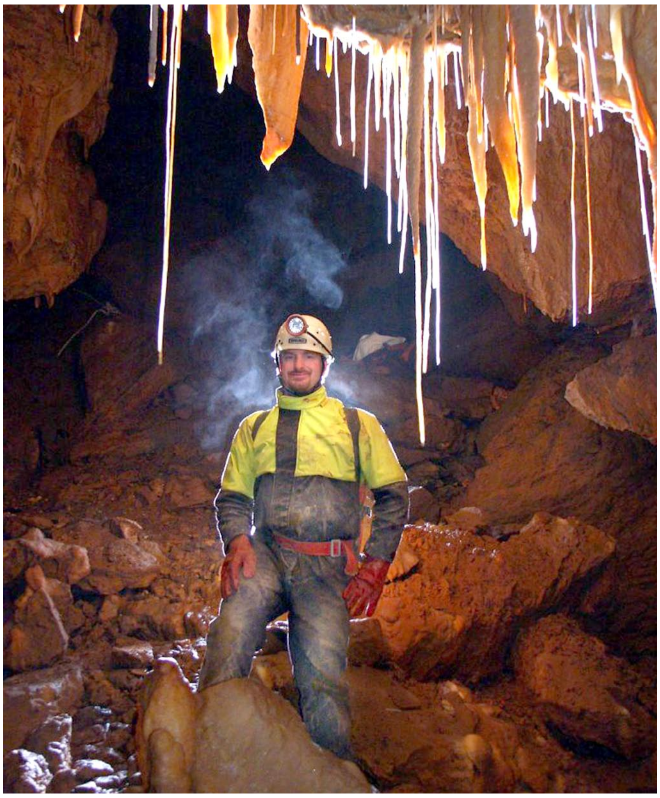


PHOTO: GARRY K SMITH

Paul in Haillie Selassie cave. Photo Competition Third Prize for a Digital photograph in the Cavers in Action category.

CAVEMANIA PARTICIPANTS

PHOTO: JLUIA JAMES

Cathie Plowman and Dave Butler selling raffle tickets.

Jay	Anderson
Ross	Anderson
Andrew	Baker
Craig	Barnes
Michael	Bates
Serena	Benjamin
Anna	Binnie
Ian	Binnie
Stephen	Blanden
Ken	Boland
Chris	Bradley
Adam	Branford
Vicki	Bresnan
Paul	Brooker
Darren	Brooks
Laurie	Brown
Grace	Bunton
Kathryn	Bunton
Stephen	Bunton
David	Butler
Alan	Caton
Arthur	Clarke
Robyn	Claire
Marie	Choi
Jason	Cockayne
Ian	Collette
Gerrard	Collins
Evalt	Crabb
Joan	Crabb
Matt	Cracknell
John	Cugley
Ian	Curtis
Paul	Darby
Melissa	Dolman
Jeanette	Dunkley
John	Dunkley
Rolan	Eberhard
Brian	Evans
Dane	Evans
Rhys	Evans
Ruth	Evans
Joe	Farrell
Albert	Goede
Glenn	Graham
Lyndsay	Gray
Saeid	Hakimi Asiabar
Nic	Haygarth
Fran	Head
Lance	Hoey
Ken	Hosking
Ian	Houshold
Debbie	Hunter
Yvonne	Ingeme
Julia	James
Bob	Kershaw
Kevin	Kiernan
Michael	Lake
Brigid	Larkin
Stephen	McCabe
Iain	McCulloch
Geoffery	McDonnell
George	MacLucas
June	MacLucas
Andrew	March
Janice	March
Denis	Marsh
Grace	Matts
Phil	Maynard
David	Merritt
Timothy	Moulds
Eric	Munro
Takashi	Murakami
Steve	Phipps
Miles	Pierce
Rhonwen	Pierce
Cathie	Plowman
Tom	Porritt
Norm	Poulter
Dorothy	Robinson
Lloyd	Robinson
Christopher	Ross
David	Rothery
Jill	Rowling
Jodie	Rutledge
Michael	Rutledge
Henry	Shannon
Chester	Shaw
Mara	Silins
Garry	Smith
Joe	Sydney
John	Taylor
Greg	Thomas
Matilda	Thomas
Bruce	Waddington
Amy	Ware
Alan	Warild
Michael	Wasmund
Winfried	Weiss
Barbara	Weisner
Jenny	Whitby
Gary	Whitby
Nick	White
Susan	White
David	Wools-Cobb
Jessica	Wools-Cobb
Reto	Zollinger