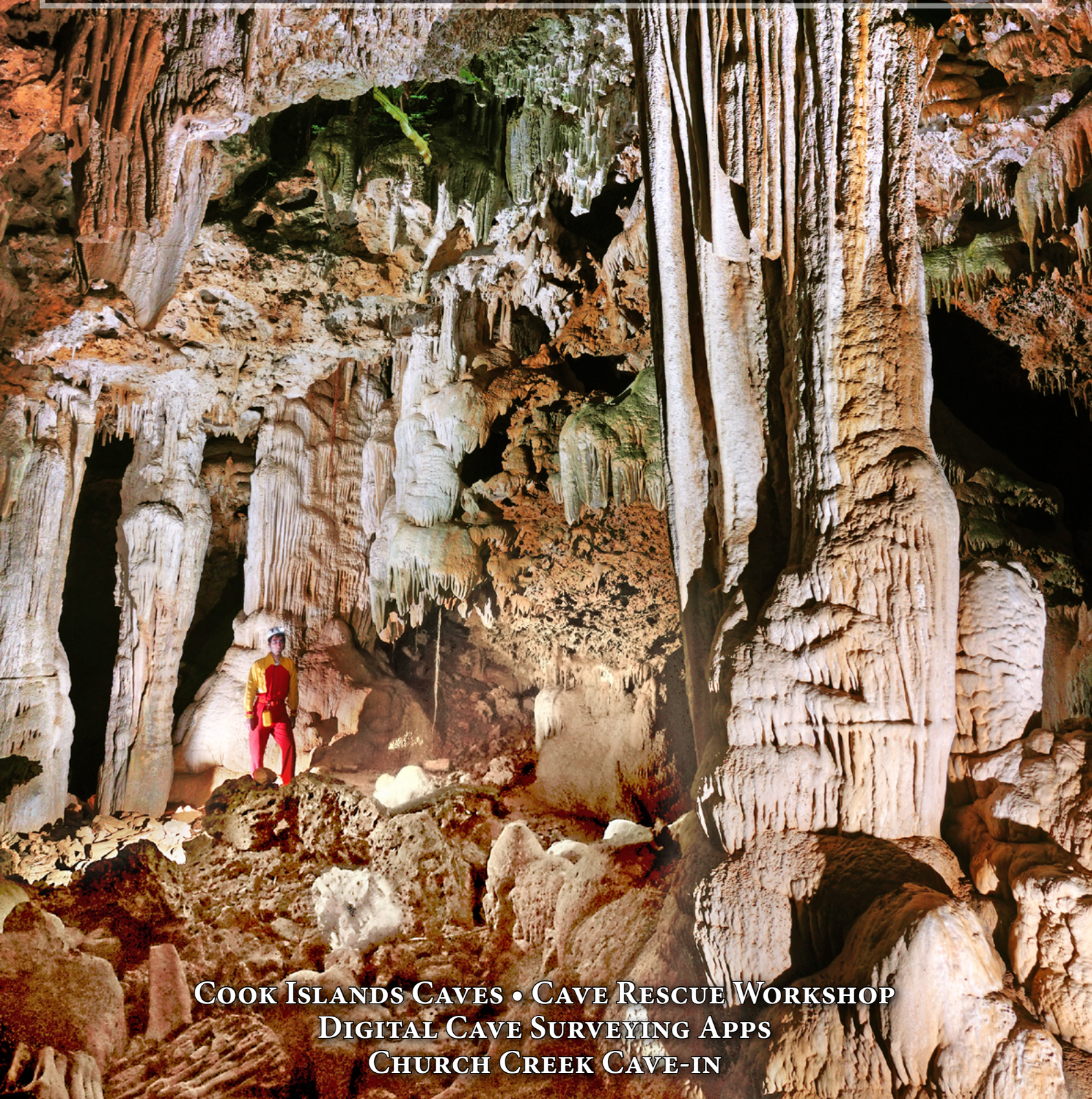


CAVES

The Journal of the Australian Speleological Federation

AUSTRALIA



COOK ISLANDS CAVES • CAVE RESCUE WORKSHOP
DIGITAL CAVE SURVEYING APPS
CHURCH CREEK CAVE-IN

COMING EVENTS

This list covers events of interest to anyone seriously interested in caves and karst. The list is just that: if you want further information the contact details for each event are included in the list for you to contact directly. The relevant websites and details of other international and regional events may be listed on the UIS/IUS

website www.uis-speleo.org/ or on the ASF website <http://www.caves.org.au>. For international events, the Chair of International Commission (Tim Moulds) timothy.moulds@yahoo.com.au may have extra information. This calendar comes to us courtesy of George Veni, President of the IUS.

2019

6-9 December

10th Spanish Congress of Speleology, (Morillo de Tou, Huesca, Spain), <https://espeleoaragon.com/xcongresoespanolespeleologia/>

2020

19-23 February 2020

International Congress: 80th Anniversary of the Cuban Speleological Society, (Caibarién, Villa Clara, Cuba), congreso80aniv.sec@gmail.com

20-24 April 2020

16th Multidisciplinary Conference on the Engineering and Environmental Impacts of Karst, (San Juan, Puerto Rico), www.sinkholeconference.com

2-8 May 2020

23rd Conference of the Australasian Cave & Karst Management Association, (Jenolan Caves, NSW, Australia), scott.melton@jenolancaves.org.au

12-15 May 2020

9th International Workshop on Ice Caves (IWIC-IX) & the 12th Scientific Conference Research, Utilization and Protection of Caves, (Liptovský Mikuláš, Slovakia), <http://www.ssj.sk/en/akcia/18-12th-scientific-conference-research-protection-and-utilization-of-caves>

13-14 May 2020

US Geological Survey Karst Interest Group Meeting, (Nashville, Tennessee), akclark@usgs.gov

18-22 May 2020

UNESCOkarst 2020: Conservation of Fragile Karst Resources, (Bowling Green, Kentucky, USA), <https://unescokarst2020.com/>

29 August-5 September 2020

19th International Symposium on Vulcanospeleology, (Catania, Italy), <http://www.19isvetna.com/>

28 June-4 July 2020

25th International Conference on Subterranean Biology, (Alba Iulia, Romania), <https://www.25icsb.com/>

12-15 July 2020

Karst Record IX (KR9) Conference, (Innsbruck, Austria), <https://www.uibk.ac.at/congress/kr9/>

27-31 July 2020

US National Speleological Society Annual Convention, (Elkins, West Virginia, USA), <https://caves.regfox.com/nss-convention-2020>

2-5 August 2020

Carbonate Critical Zone: An NSF-Sponsored Workshop, (Philadelphia and central Pennsylvania, USA), <https://carbonatecriticalzone.research.ufl.edu/>

29 August-5 September 2020

19th International Symposium on Vulcanospeleology, (Catania, Italy), <http://www.19isvetna.com/>

25-28 October 2020

Geological Society of America Convention, (Montréal, Québec, Canada), <http://www.geosociety.org/>

2021

22-24 June 2021

EuroKarst 2021: The European Congress on Karst Hydrogeology and Carbonate Reservoirs, (Málaga, Spain), <http://www.eurokarst.org/>

23-29 July 2021

18th International Congress of Speleology, (Lyon, France), <http://uis2021.speleos.fr/>

29 October-1 November 2021

SpeleoKamaraton, (Marina di Camerota, Salerno, Italy), <http://www.speleo-kamaraton.eu/>

A very useful international calendar is posted on the Speleogenesis Network website at www.speleogenesis.info/directory/calendar/. Many of the meetings listed above are on it but new ones are posted regularly.

CAVES AUSTRALIA

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ASF

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Cover: Pou Atea Cave, Atiu Island, Cook Islands - Photo by Garry K Smith

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ARTICLES FOR CAVES AUSTRALIA!

Whether caving, cave diving or generally just caving, *Caves Australia* readers are interested in YOUR story. It is only with YOUR contribution that we can produce a quality magazine for all to enjoy. For writing and style guidelines, contact the Editor or Production Manager.

EDITORIAL

THIS TIME OF YEAR is too busy to spare the time and energy required to write an editorial which attempts to offer profound insights into the caving world. A few glib one-liners will have to suffice.

2019 is drawing to a close. I've been impressed with ASF's efforts this year to start delivering on its 'strategic plan'.

The conference in January was magnificent; there's new blood on the Executive and various commissions and all the evidence suggests their hard work is paying dividends — cave rescue preparedness is arguably the best it's ever been, we have a growing social media presence, contributions to *Caves Australia* are proving reliable... and that's just the stuff I've noticed.

Thanks to all the people who help get this publication out every three months. Without contributions from the general membership, astute sub-editors and a savvy layout master there'd be little to read. Keep it up, everyone.

I think this issue has a good range of material: some history for the nostalgic, new technology for those looking forward, evidence of conservation goals achieved, science and exploration combined (and the obligatory eye candy from Garry K. Smith).

If you disagree and want to see some other topic covered, then get writing.
— Alan Jackson

President's Report

ANOTHER YEAR flies by with Christmas soon on the horizon.

Before we know it, the 2021 International Year of Caves and Karst will be upon us, so it is time for clubs to begin planning some activities to celebrate this.

If you need some inspiration, check out the official website at <http://iyccktest.uis-speleo.org/>

How the ASF will be celebrating is up for discussion on the agenda for the Council meeting on 4th January at Bankstown. If you have any suggestions or ideas, please let your council representative know.

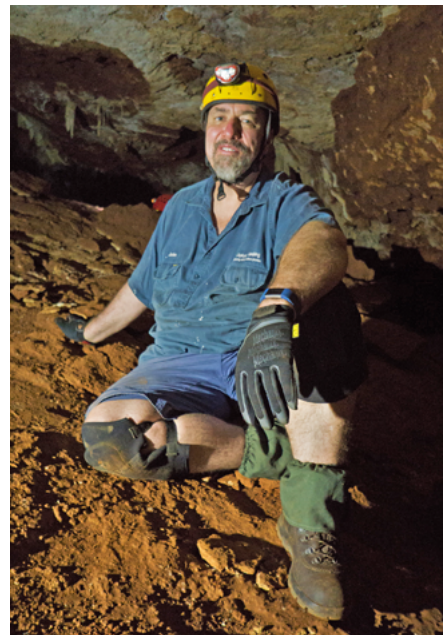
In what will be a great year for caving, 2021 is also the year that you can plan to participate in the next ASF Conference in South Australia and the International Union of Speleology Congress in Lyons, France from 25th July to 1st August.

Back on Australian soil, in September the ASF held an Executive meeting, followed by attendance in Adelaide for the Australian Cave Rescue Commission (ACRC) workshop.

Interested parties from most states and a couple of fellow cavers from New Zealand attended. It was a great weekend and a good opportunity to build networks that will hopefully stand our Federation well should we unfortunately be required to put these skills into use.

And now, for those of you who are looking to take a more active role in what is happening at the ASF, four of the ASF Executive positions are up for election.

This is your chance to get involved and



DARREN BROOKS

help steer the future direction of the ASF. There is limited impact on your caving, so if you have the spare time, please consider applying. We always look forward to fresh ideas and input.

As the year ends I would like to say thank you to all the volunteers that make the ASF happen. Your hard work and effort is appreciated.

With the festive season nearly upon us, many of you will be using the opportunities of this time of the year to get underground and spend time with family and friends. Enjoy, stay safe and look after your fellow cavers.

See you in 2020!

— John Cugley

The Cave-in at Church Creek, NSW

Tony Culberg OAM
STC

CHURCH CREEK Caves are located on Church Creek, a tributary of the Kowmung River in NSW. The Kowmung is itself a tributary of the Cox River which runs into Warragamba Dam, the primary water supply for the whole of Sydney.

Church Creek is the third of three small creeks in the area, the others being Lannigans Creek and Billys Creek. Each has a small patch of limestone, with caves at creek level. Colong Caves have always been popular with Scout groups and other non ASF type cavers. The Sydney University Rover Scout Crew marked a walking track from the Kanangra Walls Road to Colong many years before.

In the mid-1960s a cement manufacturer, Associated Portland Cement Manufacturers, (APCM) a company listed on the stock exchange, identified that Mt Armour, which is between Church Creek and Billys Creek, was limestone and lodged an application to start a quarry.

The proposal, as I recall, involved a small dam on the Kowmung, a crushing plant and a slurring plant.

The proposal was to pump the slurry to the cement works at Maldon, on the outskirts of Sydney. The route involved five changes of altitude of about 600 m each and getting the pipeline over the impoundment of Warragamba Dam, officially called Lake Burragorang. The pipeline from Savage River Mine to Port Latta in Tasmania was the model.

At this stage the Kanangra-Boyd National Park was a far-off dream for a small group, led by Myles Dunphy and his son, Milo Dunphy.

The whole area was very much wilderness and had been made fairly inaccessible when the Sydney Water Board started building Warragamba Dam just after World War II.

Access to an old silver, lead and zinc mine at Yerranderie was closed and that was the end of human habitation in 99 per cent of the area just south of Jenolan Caves.

Church Creek Caves became the focus

of a major conservation battle, spearheaded by the Colong Committee, which included Milo Dunphy, David and Malle Eden, Greg Middleton and a number of others, whose names I do not remember.

One of the tactics was to run a 'Cave-in' at Church Creek. University students were very busy at the time staging sit-ins anywhere and everywhere, in particular about the Vietnam War and conscription. We decided on a Cave-in.

I led the trip, which lasted nine days, in August 1969, including two weekends. Access was via Jenolan caves, Shooters Hill and just missing Porters Retreat before heading east towards Yerranderie.

This was all over well-known roads as caving trips to Colong Caves were regular on most club programmes. Batsh Camp (short for batshit — Colong had been mined for guano in an earlier era) was the end of the road, with a locked gate onto the only farm in the area.

The local farmer sided with APCM and would not grant access to cavers or conservationists. Fortunately, there was a public right of way between the blocks he owned or leased, known as a Travelling Stock Route (TSR).

This was to allow sheep and cattle to be walked to the outskirts of Sydney, perhaps Picton. It was out of use, because of Warragamba Dam, but still gazetted.

Various cavers, including a number from Sydney Speleological Society, had created a 4WD route along the TSR and joined the public roads on the other side of the farms. The track was rough.

We had a Land Rover and a VW fitted with snow chains, and it was a slow trip over the couple of kilometres.

There had been sporadic exploration of Church Creek Caves in the recent past. Most trips were opposed by the local farmer. On one occasion, two cars left at a campsite while the area was explored caught fire and were destroyed.

The insurance company accepted that a cooking fire must have not been properly

extinguished and paid the claims. Some cavers were not totally convinced the fire was accidental.

The cave-in was a success. A good number of bushwalkers visited the site. Two conservation-minded cameramen attended on the first weekend and their footage — all done on film back then — was sold to each of the four TV stations in Sydney and made it on to the Sunday night news. Guided tours of the (small) caves were conducted.

There was a wide range of conservation activity. Milo Dunphy was an architect and persuaded his professional body to recommend its members to specify cement powder made by an APCM competitor. Sydney Water Board also complained bitterly that the one really clean river running into its dam, the Kowmung, was at risk.

The Colong Committee obtained parcels of 200 shares from a supporter and then sold single shares to supporters at a good mark-up. The holder was entitled to attend the AGM of the company.

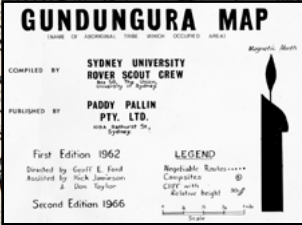
We won the votes on the proxies, but lost on the proxies. We got the publicity and cost the company lots of money, as it had to send a copy of every communication to every shareholder, as well as two dividend cheques each year.

'Save Colong' stickers were produced, to put on the inside of the back window of your car.

After the cave-in, a group abseiled the NSW Government's high-rise office block in the centre of Sydney, stopping on the way down to apply a Save Colong sticker to the outside of the Minister's office. That event made it to the evening TV news and was reported on the front page of the *Sydney Morning Herald*.

Each cave had already been named for a minister in the Liberal State Government, a tactic used later in the Gordon below Franklin campaign. 'We wish you the same tenure of office as the caves' is the message.

In the long run the hole in the middle of Kanangra-Boyd National Park was closed. The Kowmung continues to be the only



(relatively) clean river in the Sydney water system.

Part of the price was the expansion of the existing limestone quarry on the north wall of Bungonia Gorge, but that is another story.

Whether our nine days at a cave-in

made a difference will never be known — which part of a long campaign does catch the public's attention? I met some interesting people on that trip: Andrew Pavey, Warwick (Rick) Counsell and Ian Wood, among others.

Ian Wood introduced me to ASF and

its conferences, which brought me to Tasmania for the 1970-71 conference and field trips, including Exit Cave, Mt Anne and Mole Creek. And that later led to my moving to Tasmania, being Secretary of ASF for six years and also manager of its quarterly newsletter for five of those years.

Australian Cave Animal of the Year 2020

Cathie Plowman
NC

‘A CAVE CRICKET’S leap is akin to a lion’s roar’ says Sil Iannello, cricket researcher and FUSSI member.

‘They leap in a defence stance against a perceived aggressor’.

Sil has been helping me with information about cave crickets as I’ve prepared the publicity material for the Australian Cave Animal of the Year 2020.

From her I’ve also learnt that crickets store protein in their long hind legs and will eat one of their legs when food is scarce.

Cave crickets have an extensive family tree. Eight genera within the Australian *Rhaphidophoridae* family (pronounced Rap-hid-o-phor-idea) contain 22 described species and more than another five species known, but not yet described.

This ancient family originated before the break-up of the old super-continent of Gondwana. Collectively, cave crickets are the Australian Cave Animal of the Year 2020.

As most cavers would have noticed, cave crickets are generally seen near cave entrances, and they leave the cave periodically to forage for food.

Their bringing energy into the cave makes them a ‘keystone’ species for the biological food-chain within the cave, especially in caves without bats.

2020 is our second year of Australian Cave Animal and we’ve produced a new range of posters, bookmarks, stickers and



coffee/tea mugs to celebrate and promote cave crickets.

Bookmarks and stickers are free of charge and readily available.

Posters are also free of charge, but we’d like these to be placed where they’ll be widely seen, such as school classrooms and science labs, Scout and Guide halls, libraries, outdoor gear stores, show cave areas and similar rather than in cavers’ private houses. Please be in touch if you can assist with placing a poster or two.

Our coffee/tea mugs are delightful. Buy one or two for your kitchen or perhaps a Christmas gift for your caver friends. Cost is \$10.00 each (the cost price) plus postage.

The Australian Cave Animal of the Year program is inspired by the German program, which is now in its twelfth year. An

Italian program was also launched in 2019 and there are USA, Swiss and Bulgarian programs also being organised. The animals of the underground are starting to get a spotlight on them.

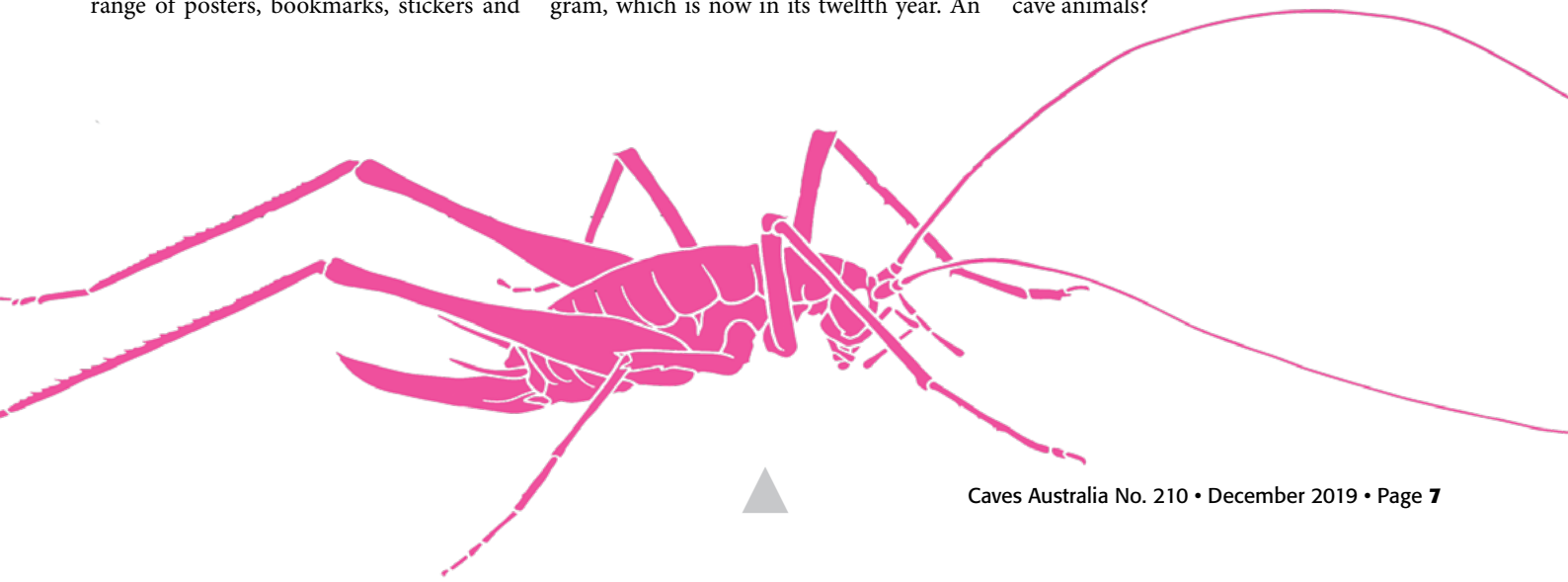
Thanks to Sam Lyne for his illustration, to Kelly Eijdenberg (Poco People) for her funky graphic design, to Sil Iannello for enthusiastically sharing her cave cricket knowledge and to the Karst Conservation Fund for financial support. We hope you enjoy engaging with the program in 2020 and helping to promote the wonder of cave animals.

More details via the links below, or contact me direct at lueena@bigpond.com
www.caveanimaloftheyear.org.au
hello@caveanimaloftheyear.org.au

AWARDS FOR CAVE ANIMAL PRODUCTS

At the 2019 Convention of the National Speleological Society in the USA, the sticker received a merit award and the Cavers’ Choice award in the Symbolic Emblem Salon. Our poster and bookmark received Best of Show in the Posters, Postcard, Brochures division of the Graphic Arts Salon.

In Tasmania, the poster won two awards in the Print categories of the recent Diemen Awards, these being for ‘Embellishment’ and ‘Commercial Items’ and it was a contender for the Grand Diemen Award for Print. How’s that for helping to promote cave animals?



ACRC National Rescue Workshop

Adelaide 20-22 September 2019

Janice March

NC

Brian Evans

Coordinator of the Australian Cave Rescue Commission

PREPARATION for cave rescue in Australia has been evolving for many years, but the interconnectedness of cave rescuers from across the country has recently been boosted.

The ASF's Australian Cave Rescue Commission Coordinator, Brian Evans, organised a weekend workshop in Adelaide in September 2019 which was attended by 31 cavers from around Australia, plus two New Zealanders.

Up to two attendees from each region had their flights subsidised by the ASF so that they could come together face-to-face to discuss their passion for rescuing people out of sticky situations in caves.

Our enthusiasm was further ignited as we listened to cave divers Richard Harris and Craig Challen relate their experiences as part of the successful Thai cave rescue team.

These chaps, of course, have been thrust into the spotlight as Australians of the Year, but after running us through their down-to-earth perspectives of the events of July 2018, they managed to pass on some useful tips about dealing with the potential media interest in any future cave rescue.

The Cave Divers Association of Australia has a high level of preparedness for emergencies and pre-planning for all the commonly dived caves around Australia.

In some diving caves, dry cavers and cave divers would be required to work on different aspects of a rescue.

Next we heard from John 'Oz' Patterson and Chris Whitehouse who are both heavily involved in the New Zealand Speleological Society's NZ Cave Search and Rescue system.

There are many more rescues per year in New Zealand's extensive and deep cave systems than in Australia.

The NZ cavers have close relationships with the NZ Police and Land SAR. They train at regular national and regional inter-agency cave rescue exercises.

Their national exercise is held triennially and took three days this year. There is a cave rescue course available for aspiring cavers interested in rescue.

Oz built up a picture for us of a well-oiled machine of cavers across NZ experienced in all different scales of rescues and used to working with the emergency services in their region.

He emphasised the long list of jobs that cavers would be called on to perform in a rescue — everything from route finding, accompanying paramedics, advocating for the casualty, gear carrying, rigging, to solving in-cave communications problems.

Importantly, he has noticed over the years that cavers are also needed on the surface to assist incident controllers who don't necessarily understand 'caver-speak', as expert advisers, to monitor rescue worker welfare, use specialised cave communications systems and act as entrance controllers.

He introduced us to the idea that on-paper scenarios are very helpful for preparing cavers for being part of the incident management team.

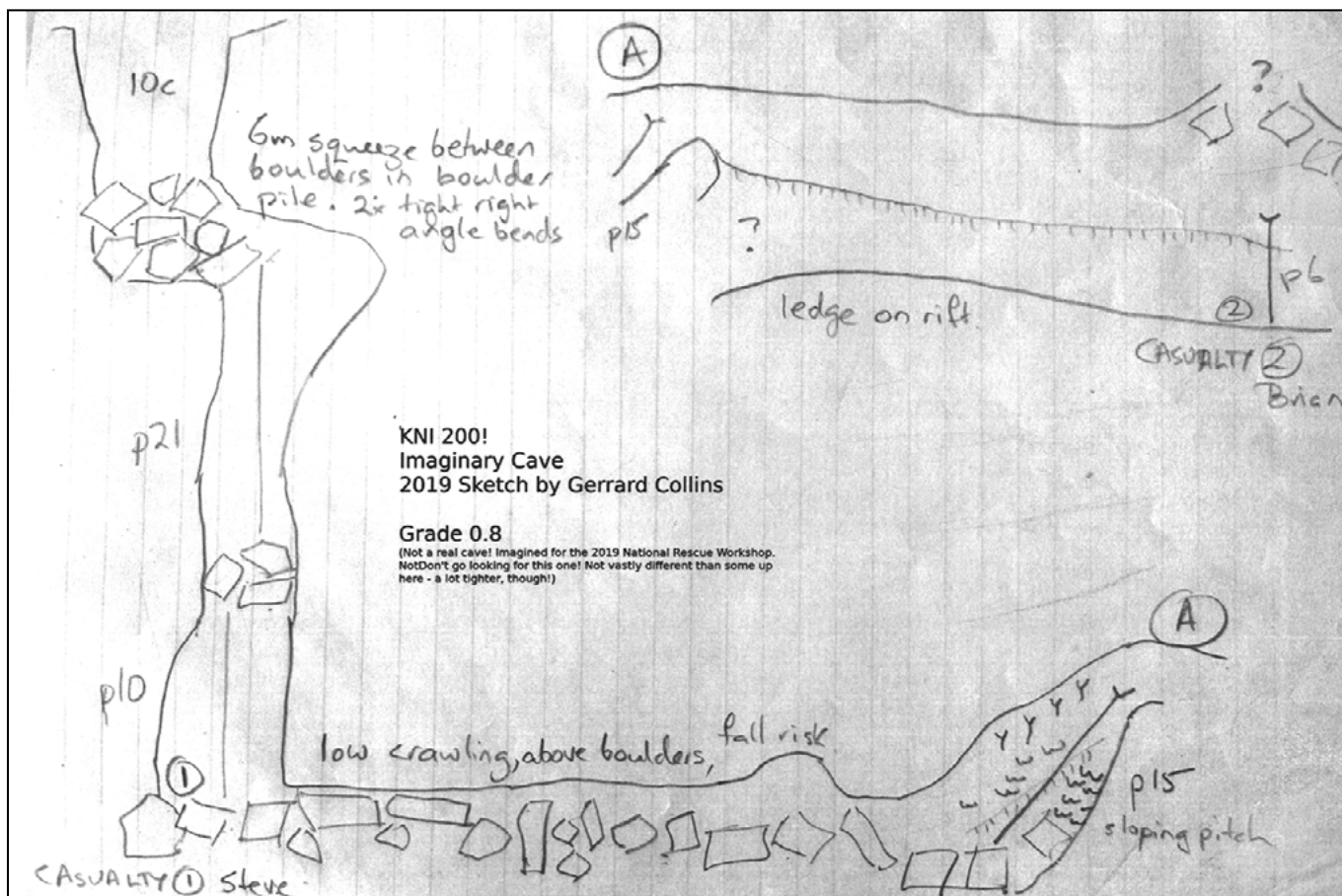
They make you plan for all the logistics and operations needed during the rescue. Part of New Zealand's cave search and rescue Coordinated Incident Management System is to have a 1-2 page pre-plan covering all the essential facts about a rescue from XYZ Cave.

These should be written and kept handy by anyone likely to be phoned late at night by the police and act as a reminder of what



Workshop participants line up for the obligatory team photo

DEBORAH HUNTER



The imaginary cave used in the on-paper scenario

TABLE OF ACTIONS

A gathering of 'regional drivers of cave rescue' in Adelaide enthusiastically discussed and planned ways to increase Australia's cave rescue preparedness.

During the final session of the workshop we discussed what we considered to be key actions.

This is a draft list of ideas, not a formally adopted or agreed actions list. Items are not listed in any order of perceived priority.

A SUMMARY:

'Rescue from caves is very low in frequency but very high in complexity'

We have some tasks to do...

LOCAL ACTIONS:

- Get involved with your local cavers interested in cave rescue.
- Make sure your club has a safety officer/rescue officer and that they are actively communicating between your members and the ACRC.
- Do some practice in self-help for injured cavers on your trips – make sure members understand that rescue will be difficult.

REGIONAL CAVE RESCUE ACTIONS:

- Keep training and bringing others in.
- Build in systems that cope with the key players being away – it's inevitable that they will be!
- Work hard at developing relationships with emergency services and land managers.
- Develop brief pre-plans for rescue responses for the most likely situations.

NATIONAL ACTIONS:

- Support cave rescuers in training.
- Help relationship building with emergency services.
- Encourage cavers to be rescue-aware and avoid accidents.
- Build links with international cave rescue.
- Facilitate interstate communication of callout information and rescue resources available.

TAKE HOME MESSAGES:

- Capability database with contacts.
- Standardise format of capabilities, all states use same format.
- List of resources/equipment/maps/surveys available. Where? Who is the contact? Who updates/maintains?
- Form an ASF safety/rescue sub group:-
 - Formal focused meetings;
 - Tasks;
 - Follow up.
- Clubs should have a safety officer, and report through State Speleo Councils.

- Relationships made with police/emergency services:
 - We need to show we are competent, then we'll be called.
- How do transport logistics work? – If police call cavers, they handle transport
- Memorandum of Understanding between NZ and Australian cavers:
 - Recommend vertically competent cavers who are able to attend ASAP;
 - Encourage arrangements between governments;
 - Pacific nations too.

- We should work on this now, following up on enthusiasm of this workshop, Thailand. Check on how the Europeans do it...
- We need a group of passionate/prepared cave rescue needs to be responsible for knowing who or what for their state.
- Incident management training gives us credibility when working with emergency services.

WHERE TO FROM HERE?

- Similar meeting every three years.
- Funding:
 - Increase ASF fees by ?? a year to fund cave rescue?
 - Emergency services grants to build community resilience/relationships.

- Start of development of skills and capabilities – next meeting to build on what is happening/set new goals – shouldn't be the same as this one.

- **OBJECTIVE:** form a sub-committee ('commission') to act on proposals by end November.

ACRC thanks all participants and those who helped it all come together



Load testing temporary rock bolts



Familiarisation with communications equipment

sorts of things need to be organised for an imminent deployment.

The police like to see a map of the cave, so simplified surveys are also kept at hand with pre-plans. We divided into groups to do a paper scenario.

Two serious injuries had occurred to a fictitious party of four cavers in a tight vertical cave in the East Kimberley.

Firstly, the groups discussed the initial advice to local police by a caver on the phone in a capital city, then the scenario unfolded: the petite policewoman could fit through the tight entrance passage but only a rolled-up stretcher, not a loaded one, would fit.

We hypothesised much outside assistance from cavers from around the country to form medical, communications, de-obstruction and rigging teams, and local SES to deliver equipment, water, food and shelter to the campsite forward control centre and the cave entrance.

The scenario highlighted the difficulties associated with call-outs to remote caving areas as well as the fact that local emergency services will likely rely heavily on cavers to advise them on what resources, skills and personnel will be required to perform the rescue.

Working in groups and mingling socially during breaks also allowed everyone to get to know a bit about each other, so at least now we will know on whom we may be calling one day for assistance if

something big happens in our area.

TO DO LIST:

- Create an improved database of rescue-interested cavers' contacts with a nationwide standardised format for rescuers' capabilities;
- Create a list of rescue resources available around Australia, where they are located, who maintains them, and who to contact should you wish to use them;
- Form an ASF safety/rescue committee to assist Brian as Commissioner with focussed meetings and tasks to accomplish;
- Clubs should all have a safety officer and report on rescue training through their state Speleo Councils. We need a group of passionate cave rescuers to be responsible for the knowledge of each state's cave rescue capabilities;
- Investigate having a national number to call for Cave Rescue that is channelled to the appropriate regional rescue coordinator;
- We need to reinforce relationships with emergency services and Police to show we are competent, so we are called out for authentic rescues. Incident management training gives us credibility when working with emergency services and courses are available;
- We will develop a memorandum of understanding between NZ and Australian cavers, including a list of

vertically competent cavers able to attend a rescue at short notice and encouraging arrangements between governments. This may assist with our ability to help rescue cavers in Pacific nations too;

- We should examine how cave rescue is done in Europe and elsewhere and see what we can learn from it.

CONCLUSION

Thanks to funding from ASF, state government grants and club funds, there is now a fair amount of specialised cave rescue gear around the nation available to take on your next expedition and use for rescue or exercises. Likewise, most regions now have a core of people competent to move a casualty, even in difficult parts of caves.

Regional cave rescue coordinators now have online access via Dropbox to a host of templates, eBooks, NZ pre-plans and resources for cave rescuers.

Funds may be needed from ASF or from emergency services grants to increase community preparedness for cave rescues.

The gathered cave rescuers suggested that an increase in ASF fees to support rescue preparedness might be supported by members.

This meeting could possibly be reconvened in a few years' time to follow up on the progress made towards better preparedness for cave rescue all around Australia.

ACRC thanks all participants and those who helped it all come together.

Karst and Caves of Atiu, Cook Islands

Garry K. Smith¹, Andrea Borsato², Silvia Frisia²,
John Hellstrom³, Adam Hartland⁴ and Mohammadali Faraji²

THIS ARTICLE provides a basic overview of the recent research work undertaken on Atiu, in the Cook Islands Archipelago, its geology and caves.

During October 2018, a two-week research expedition was undertaken in the caves on the island of Atiu, in the Southern Islands group of the Cook Islands, to gain an understanding of what drives rainfall in this part of the world by interrogating past climate records. The field trip to the caves in Atiu was part of the Australian Research Council (ARC) Discovery project 'South Pacific and Australian hydroclimatic history recorded by stalagmite calcite fabrics,' which approaches the story of past climate by using annually stacked crystals in cave formations. Silvia, Andrea and John are the Australians leading the team, joined by their PhD student Mohammadali Faraji. Adam Hartland is the New Zealand colleague, keen on looking at the nature of cave waters, and finally, I have been involved in my role of cave surveying and photography.

The research work looked at stalagmites and flowstones as reliable gauges of past variations in annual rainfall patterns. Trends and cycles may be due to specific causes, such as changes in temperature of the ocean surface, or small changes in energy from the sun, or even unknown behaviour of clouds. Stalagmites and flowstone have become some of the most important archives of rainfall changes, because they are directly related to rainfall via the water that infiltrates into the cave, which carries with it the signals from the atmosphere (Figure 1).

Our work in Atiu has the final goal of understanding changes in a band of clouds called the South Pacific Convergence Zone which brings rainfall to the South Pacific Nations. This band of clouds can be shifted to the north or south and changes shape when affected by another important band of clouds, the Intertropical Convergence

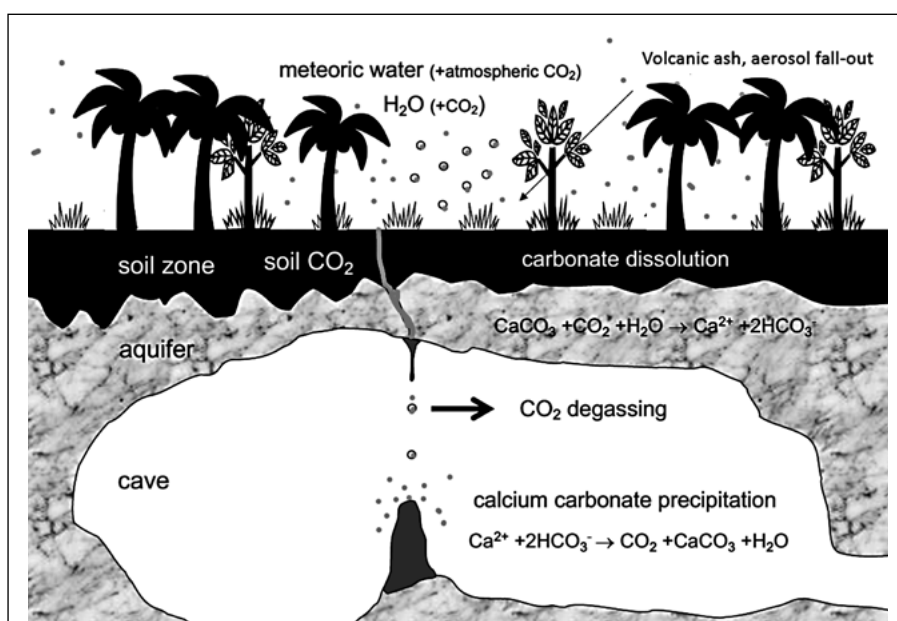


Figure 1: how surface climate is transferred into stalagmites and flowstones within the cave. The infiltration water carries the signals of the rain in its oxygen atoms (in the form of O isotope ratios). This signal changes according to how much it rains. The rainwater percolates through the soil, where it picks up CO₂ from roots and microbial respiration. The C now dissolved in the water carries the signal of the soil and its variability is related to the more efficient respiration (or less efficient) that occurs when it is wet (or dry). The infiltrating water also takes up some trace elements from the soil, for example Fe, or S from volcanic ash, or P from plants or even the marine aerosol. The infiltration water plus CO₂ has become a weak acid that dissolves the limestone and picks up calcium and a little bit of magnesium and strontium. Finally, the water enters the cave, releases the CO₂ to the cave atmosphere and is ready to form calcite containing all the signals from the surface. Those from the rock give us an idea of how long the water remains in the limestone, which is longer when it is dry. The dry period cave water will have more strontium and magnesium than the wet period water. So, we have plenty of cross-related information to find out how much it rained in the past (Adapted from Frisia & Borsato, 2010)

Zone, which influences rainfall in Australia. Thus, what happens in Atiu has consequences also for us. That is because Earth's climate is complex and all is connected through the atmosphere and the oceans.

There were three caves of special interest, which had been identified three years earlier by Andrea and Silvia. The focus of the 2018 trip was to explore, survey and

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collect calcite deposits formed on previously placed drip stations. Our researchers wanted to study the crystals formed during wet and dry periods, monitor cave physics and water chemistry. This monitoring is fundamental for cave scientists to interpret stalagmite annual hydroclimate records.

The weathering rate of the karst was also of interest to the researchers, because little is known about the age of the karst and the caves. Thus, we collected relict samples of ancient stalagmites and flowstones occurring today on the surface of the limestone (paleokarst).

The caves on the islands have been known to the first human inhabitants since shortly after their arrival by canoe, believed to be around the 14th century. The arrival of intrepid Polynesian sailors with families, domesticated pigs and taro is evident because of the marae (sacred meeting site structures) they built out of stalagmites and columns extracted from the caves and used to mark the perimeter of the structures. The space between columns, which were laid down horizontally on the ground, was filled with white sand from the beach. Tools fashioned from basalt, which is much harder than limestone, were used to mine the speleothems.

The first recorded European to arrive at Atiu was Captain Cook, who sighted the island on 31st March 1777. Two of his crew eventually landed at a small beach called Ora Varu (Captain Cook's Landing), after being coaxed ashore by the islanders. In 1821 missionaries from the London Missionary Society began to work in the Cook Islands and the coastal dwellings were abandoned for villages higher up on the ancient volcano, where they are now. Some marae still marked by stalagmites and columns can be seen in the modern villages.

Today there are 5 villages that have merged to form one at the top of the island plateau. Roads and tracks radiate out from the hilltop and join a ring road, which follows the coastline. The whole island can be easily circumnavigated in an hour by motorbike and there are plenty of interesting things to stop and take in along the way. These include the wharf, harbour, Cook's Landing, coconut groves, marae sites and several churches.

During our research field trip we stayed at the well appointed Atiu Villas, which afforded the comforts of home and proved to be very convenient for day excursions to the various caves around the island and the coast. It must be pointed out that the caves are all located on local owners' land and special permission had been obtained from the Council of Atiu and landowners in order for us to visit them. Tourists can

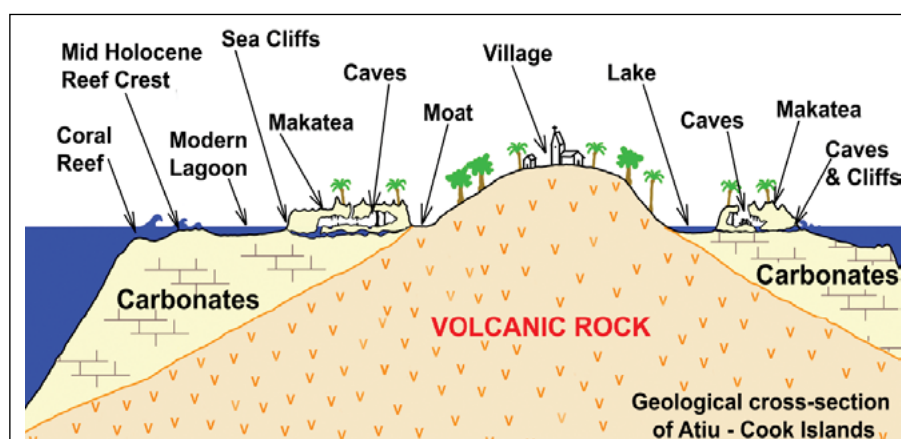


Figure 2. Schematic geologic cross section of Atiu, re-drawn from Dickinson, 1998 and, for the submerged part inspired by the work of Mylroie and Mylroie (2007). The modern reef was added after observations conducted by Frisia and Borsato in October 2010 and 2019.

visit just a few caves. The most interesting is Anatakitaki Cave that is the home of an endemic species of the swift family, the rare kopeka bird.

Another cave visited for leisure is Vai Araruku Cave and its plunge pool, in which the water level rises and falls several cm with the ocean tides.

During our visits we noted a large eel, some fish and crabs in the deep body of water in this cave. Obviously there are connections to the ocean, not large enough to allow a free flow of tidal water to fully influence the cave water height, but large enough to allow marine creatures to enter and adapt to the brackish waters.

Karst and caves in Atiu are of significance in that they tell us about past climate, provided construction material for early inhabitants and are home to unique fauna. The existence of these caves is due to the geological history of this island.

GEOLOGY OF ATIU AND THE MAKATEA

Atiu is a small island, roughly oval and measuring approximately 4.5 x 3 kilometres. The centre of the island is a flat topped plateau (70m ASL) formed by weathering and erosion of an ancient volcano. The volcano is rimmed by a raised coral reef about 1.6 km wide separated from the volcanic hill by a moat, now occupied by wetlands and a lake. This fossilised reef is known as *makatea* and has been dated to the Pleistocene, but the limestone may be much older, as the age of the volcanic island may be as old as 5 million years (Dickinson, 1998). The limestone (*makatea*) represents ancient, uplifted fringing reefs that now form girdles around the volcanic core of the island. These girdles have diverse heights, which reflect a very complicated story of global sea level changes, and local sea level variability related to the bulging of the

lithosphere associated with the birth of the Rarotonga volcano (Dickinson, 1998). The youngest *makatea* forms a cliff in excess of 6 metres towering above the present lagoons, which are protected from the energy of the ocean waves (generated by the South Pacific) by fringing reefs (Figure 2).

There are many swamps located in the contact zone between the island's central volcanic cone and the limestone. They form a natural freshwater storage area which gradually percolates through the aquifers into the water table of the *makatea*, thus reducing the ingress of salt water from the ocean.

The *makatea* has a jagged, pitted surface cross-cut by irregular karren, which results in razor sharp features. Any slip when crossing it could result in serious injury, including broken bones and deep cuts, which can quickly become infected in the high tropical humidity.

This morphological aspect is well known for the coastal environment of tropical carbonate islands (Folk *et al.* 1973). Folk *et al.* (1973) ascribed the razor sharp and pitted surface of tropical island karren to marine spray, boring endolithic algae and grazing by gastropods.

Subsequently, Taboroši *et al.* (2004) demonstrated that the key factor for the evolution of a jagged karst surface was the lack of diagenetic maturity of the rock. Diagenesis is the process that changes a sediment into a rock through compaction and cementation. In the case of carbonates, much of the cementation is by other carbonate, which is released by the dissolution of the original carbonate minerals. This etching of the *makatea* is typical of young carbonates.

Beneath the surface, the action of dissolution has created an extensive horizontal maze of cave passages, which host speleothem carbonate deposits.





Skylight #4, Pou Atea Cave, Atiu Island, Cook Islands

CARRY K SMITH

THE CAVES

Atiu is a composite island, with a volcanic core, rimmed by carbonate rocks (Mylroie & Mylroie, 2007).

The makatea is a limestone, which formed in seawater and was originally born as a mixture of lithified reefs and microatolls, loose carbonate grains and lithified beachrock (cemented beach rubble and grains). The original reef and lagoon deposits were transformed into a highly

porous rock through a process known as dissolution-precipitation. This process created pores and fissures of various sizes on the one side and pervasive cementation on the other. Thus, the pattern of porosity of the makatea limestone is unpredictable, which results in different clustering of speleothems within the caves.

Commonly, Atiu caves are extensive horizontal maze systems with interconnecting large chambers and passages.

Navigation through these labyrinths can be confusing without a quality map as a reference. Typically, the larger chamber ceilings extend to within just a couple of metres of the surface, and the lower parts of the caves reach the water table at a depth of approximately 10 to 18 metres. Some caves contain deep pools of crystal clear aqua-coloured water and those closer to the coast generally have water level fluctuations influenced by the ocean tides. Cave entrances are often



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Pou Atea Cave



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Garry and Mohammadali surveying in Pou Atea Cave



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Silvia with pool speleothems in Nurau Cave

located at the base of collapse dolines, created by the collapse of thin roofs of large voids formed at the top of the freshwater lens (Myroie and Vacher, 1982). The ceilings of large chambers may reach all the way to the surface, allowing some light to penetrate into the cave, as well as tree roots. The existence of many stalagmites and flowstones on the cave floor suggests that the current hydrology is mostly vadose. In many places stalagmites have fused with stalactites to become columns, reaching the ceiling in large chambers and are now supporting the thin limestone layer above, preventing it from collapsing. Percolating

waters saturated with calcium carbonate have also created cave pearls up to 50 mm diameter, which cover vast areas of the cave floor between mazes of rimstone dams.

Occasionally the clicking sound of echolocating Kopeka (Atiu swiftlet) could be heard as they navigate the cave passages in total darkness. Every cave appears to have a healthy population of crabs up to the size of a spread human hand.

Pou Atea Cave (also spelt as Pau Atea)

This cave has five entrances, two of which are free-climbable. The other three

require vertical caving gear to enter. There are numerous large maze passages and chambers with massive columns, which majestically appear to be the only support holding the large expanses of roof up. Evidence of speleothem extraction by the early island inhabitants can be found throughout the cave. It has a surveyed length of 965m and the depth from makatea surface to the water table of 18 metres. The cave is not far away from the contact with the eroded volcano, and red soil created by the weathering of volcanic rocks fills pockets and ridges between karren and pinnacles. The stalagmites from this cave appear to consist



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Andrea, Adam and Mohammadali collecting water samples in Nurau Cave



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Map-eating crab in Nurau Cave



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Skylight #1 chamber in Pou Atea Cave



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Mohammadali in Pou Atea Cave

of porous calcite and compact calcite layers. These two diverse calcites testify to the alternation of different hydrologic regimes, with the porous calcite full of particulates likely forming when the infiltration is fast enough to carry soil particles to the stalagmites.

Nurau Cave

The entrance to this cave is at the bottom of a large collapse doline approximately 18 metres diameter by 5 metres deep. At the back of the cave there is a clear deep aqua-coloured lake with a surface area of approximately 3 x 5 metres. The lake was

explored by Australian divers, David Goldie and Paul Tobin in 1997, who reported that it leads to an extensive underwater labyrinth of passages. They produced a survey map from their exploration. Then in 2017, Rod Obrien and Bruce Clulow dived the lake and discovered more passage. They surveyed 320 metres of underwater passage to a depth of 12 m and reported that the cave continues in passage with water flow, well past their furthest survey point. They saw an abundance of aquatic life such as eels and fish and observed a considerable quantity of large underwater speleothems. (Obrien – pers. comm.)

At the time of our visit the lake had a scattered array of calcite rafts over the surface. This cave also had evidence of speleothem extraction by the early island inhabitants. The total survey length of the cave is 407 m and a depth of 14 m from makatea surface to the water table. This cave has honey-coloured stalagmites consisting mostly of compact and very hard calcite. The dark colour is commonly related to the presence of organic compounds.

Vai Araruku Cave

This cave was originally used as a water source by the early inhabitants of the island.



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Skylight #5, Pou Atea Cave



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Crab in Nurau Cave



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Val Aruruku Cave

The large sloping entrance is located at the base of a cliff on the east side of a collapsed doline. It has a total surveyed length of just 61 m and a depth of 17.6 m from the surface of the makatea to the water table. The cave has several interconnected pools of deep clear aqua-coloured water. Fish, eels and crabs were spotted in the pools.

EXPEDITION LOGISTICS AND ACTIVITIES

We flew from Sydney to Rarotonga with Air New Zealand and then on to Atiu with Air Rarotonga. Thankfully our hosts at the Atiu Villas accommodation knew of our

arrival time and had arranged for a couple of vehicles to pick us up from the small airport, which for the most part is unmanned. It should be pointed out that the Air Rarotonga twin propeller planes are small and weight restrictions mean that some of your luggage may arrive on another flight if the seats are all allocated.

There is a shop on the island with limited supplies, so if visitors have specific dietary requirements or need special equipment then it is worth organising this in advance with your accommodation provider or do a grocery shop in Rarotonga and have it flown to Atiu. There are limited numbers

of motorbikes and vehicles, which can be rented for transport around the island.

Our expedition members brought all the supplies we needed on Atiu for the research work, which included surveying, photography, cave monitoring and water collection equipment.

The caves were surveyed with a Leica Disto X310, fitted with a DistoX2 upgraded kit to allow measurement of inclination and bearing in addition to distance. As the survey data was being recorded by the laser DistoX2, it was automatically uploaded to a Samsung Galaxy S2 8.0 tablet and into a cave survey drawing program



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Columns in Pou Atea Cave



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Sea cliffs (6 m high), beach and lagoon, Atiu Island



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Mohammadali near dripstone pools, Pou Atea Cave

called TopoDroid. This setup allowed disto measurements to be taken by one person, while another accurately sketched the cave and added details on the tablet, at the same time. The TopoDroid program makes it easy by calculating the true horizontal and vertical true lengths for each measurement (radials and legs) and draws them as accurate lines for the plan and section views.

Surveying of the caves in places was made difficult by crabs eating the pink fluoro flagging tape, which was used to mark stations. It was difficult to verify loop closures when the tape was gone by the time we got back to the station! On

one occasion I had a tug-o-war with a crab, determined to drag my flagging tape down its hole between the rocks. Later on a crab grabbed our paper map and began devouring it. There were several species of crab throughout the caves and they were everywhere. So, no leaving lunches, paper maps or flagging tape unattended.

Cave monitoring consisted of measuring the concentration of carbon dioxide in the cave air, measuring the drip rate (time elapsed between two drops) at various sites, collecting water samples for trace element analyses, measuring water pH and electrical conductivity, measuring dissolved

carbonate content in the dripwater, and carrying out experiments of calcite precipitation in the cave. All of this information is then used to interpret the record from the stalagmites, with the ultimate goal of advancing our knowledge on the effects of climate change.

PHOTOGRAPHY

As part of the research project, photographs had to be taken of all aspects of the cave including passages, chambers, speleothems, research sampling and fauna. For this purpose a Sony RX10IV camera was used in conjunction with Metz 30BCT4



Speleothems in Pou Atea Cave

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Tree on the track to Pou Atea Cave



Marae (sacred ceremonial site) made from stalagmites and columns, Atiu Island

GARRY K SMITH

flashes, fitted with Firefly slaves. This allowed photos to be taken with up to 5 flash units going off at the same time. Ideal for capturing the true beauty for large chambers and passages.

SPECIAL THANKS TO

The local Council of Atiu, Roger Malcolm at Atiu Villas, the landowners/custodians of the land and all the wonderful people in Atiu, the Australian Research Council for supporting the research 'South Pacific and Australian hydroclimatic history recorded by stalagmite calcite fabrics' through a DP grant, Prof. Dave Matthey for setting the first cave monitoring at Atiu.

REFERENCES

- Dickinson, W.R., 1998. Geomorphology and geodynamics of the Cook-Austral island-seamount chain in the South Pacific Ocean. Implications for hotspots and plumes. *International Geology Review*, 40(12), pp.1039-1075.
- Folk, R.L., Roberts, H.H., and Moore, C.H., 1973, Black phytokarst from Hell, Cayman Islands, British West Indies. *Geological Society of America Bulletin*, v. 84, p. 2351-2360.
- Frisia, S., and Borsato, A., 2010, Chapter 6 *Karst: Developments in Sedimentology*, v. 61, p. 269-318.
- Myloie, J. and Vacher, H. (1999). 'A conceptual view of carbonate island karst.' [in] Palmer, A.N., Palmer, M.V., Sasowsky, I.D. (eds.), *Karst Modeling*. Charlottesville, Virginia. Special Publication no. 5, Karst Waters Institute. p. 48-57.
- Myloie, J. R., and Myloie, J. E., 2007, Development of the carbonate island karst model. *Journal of Cave and Karst Studies*, v. 69, no. 1, p. 59-75.
- Taboroši, D., Jenson, J.W., and Myloie, J.E., 2004, Karren features in island karst. Guam, Mariana Islands: *Zeitschrift fur Geomorphologie*. N.F., v. 48, p. 369-389.

Need Emergency Back-up for Your Next Expedition?

Brian Evans

Australian Cave Rescue Commission

FOR MANY of us, the best caving is for extended periods in out-of-the-way places.

There, apart from getting to explore new cave, we also know that we need to be self-reliant – any accident or medical incident that we can't look after ourselves is a v-e-r-y long way from help.

Potentially, for even a relatively minor issue, it is likely to be days before external assistance is able to help — especially if it happens in a tight or tricky cave.

ASF council, in Tasmania, decided that members could benefit from having additional incident response equipment available for expeditions. In the case of an incident, the availability of a stretcher, satellite communication or AED could make an enormous difference to the outcome.

Quite a few members have bought



Testing cave rescue equipment during a vertical rescue exercise in Argyle Cave, NSW

satphones and a few clubs have obtained stretchers, but it was felt that any member who wished to take such equipment out caving should be encouraged. Hence it was decided to purchase this equipment and make it available.

FUSSI in Adelaide have made their equipment available to all ASF members, which is an excellent thing.

ASF has purchased a set to be located in Perth, so that expeditions heading out through either of those cities can pick up the equipment. If there is demand, more can be purchased.

The equipment and procedures are now in place for ASF members to borrow equipment to support safety on expeditions.

Please use the service — if an incident occurs, the equipment is likely to greatly improve outcomes!

A stretcher and satphone can be picked up from Adelaide and taken north or west, or wherever, and, in Perth, a stretcher, satphone and AED are available. It is also possible to get the equipment freighted to somewhere more suitable for your team.

Toad Hall Goes On Line

Clare Buswell

FUSSI

Ken Smith

CEGSA & FUSSI

THE CAVE-LINK communication system was successfully used to send messages from Toad Hall in Cocklebidy cave to Adelaide via SMS.

The recently purchased state of the art cave communications system underwent testing on the Nullarbor when the Wet Mules took the system into Toad Hall. The Cave-Link system is used extensively in Europe, the UK and in New Zealand. It was the only comms system used in the 2014 14 day rescue in Riesending Cave, Germany.

The Flinders University Speleological Society Inc (FUSSI) purchased the system in August to bolster its remote caving capability and is in the process of testing it in remote locations. The system consists of a surface unit with GSM capability and a below ground unit with a printer and signal horn. The system uses text messages to communicate. The below ground

unit does not require a person to be with it at all times, as the horn activates loudly when a message is received. Where mobile coverage is available messages can be sent from the underground unit via the surface unit to a mobile phone and vice versa. At Cocklebidy, messages were sent directly from Toad Hall to Adelaide and back.

The principle of communication is ground conductivity. Each unit has two electrodes inserted in the ground at a spacing of up to 50 metres. Digitally encoded current pulses are injected into the ground and picked up by any unit within range. Messages are automatically saved with a time stamp and can be printed at any unit with a printer attached. Cave-Link can have up to 14 units communicating on a single network. This allows communication with multiple locations in the cave. Also the range can be extended by directing mes-

sages from one unit to the next over several units. Maximum range from one unit to the next can be up to 1 km depending on geological conditions and any electrical interference.

The testing undertaken on the Nullarbor shows that if an accident happened in Toad Hall, which is 4 km from the entrance, notification time of an accident via cave-link to the outside world would be significantly reduced.

Oz Patterson from NZSS provided invaluable advice when the unit was first tested here in Adelaide at the ACRC recent national seminar on rescue. As a result the unit has been used in a recent SAREX event in Tasmania and will be used in another in Western Australia. FUSSI is working with the ASF's ACRC about how Cave-Link can add to the national cave rescue response processes that are being developed.

Beginning systematic temperature and humidity measurements in Nullarbor caves

Matej Lipar and Mateja Ferik

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THE Nullarbor Plain is a unique karst landscape, reflecting long-term landscape and environmental changes. These are all indicated by cave features such as flowstone and sediment deposits as well as landscape, topography and geology.

The better the knowledge we have of the Nullarbor karst, the better we will know what we have to protect, how to manage it and how to preserve it. Although often referred to as 'flat', the Nullarbor preserves ancient topography imprinted in limestone; currently we are studying the processes responsible for the subtle variations in the landscape. Our extensive data collection and successful sampling will now be followed by various laboratory analyses and to bring to light interesting new data about the 15-million-year landscape history.

Nevertheless, when talking about the landscape and climatic history, it is important to know the present climatic characteristics of the Plain. Some can be reached through the BOM website, but there are no data about the subterranean climate — the one that is strongly connected to the surface climate, but at the same time acts on its own. Some temperature data measured on spot have been published, such as groundwater temperature and cave temperature, but these are rather 'weather' data than 'climatic' data, which need systematic long-term measurement to recognise general climatic patterns. This is why we decided that, in addition to surface field work, the installation of the first automatic climatic loggers in Nullarbor caves is desperately needed and should be done as soon as possible. Why as soon as possible? Because, to get the first useful climatic information, the data will have to be collected for a number of years (generally, trustworthy climatic data are calculated on 30-year averages).

Thus, the Australian Speleological Federation Karst Conservation Fund (ASF) provided funds for 5 high-quality Tinytag



Figure 1: The final chamber in Abrakurrie Cave. Notice the caver standing on the rock pile with the log book. The logger is situated on the wall to the left of the caver

temperature and humidity (T&H) automatic data loggers with 0.01°C error. In addition, the Geographical Institute at the Research Centre of the Slovenian Academy of Sciences and Arts (GIAM) provided funds for five more loggers plus the anemometer logger to measure wind direction and speed.

Prior to installation, the loggers were first calibrated. Each of them was also named to reflect its funder: ASF 1, ASF 2 ... ASF 5, and GIAM 1, GIAM 2 ... GIAM 5. As there was only one anemometer, it simply remained the GIAM anemometer. All of the loggers and the anemometer are set to

Australian Western Standard Time.

The first T&H logger (ASF 1) was installed in Blowhole Cave (6N-337) next to a track between Forrest and Eucla. This is an active blowhole and the temperatures will indicate the blowing regime. It is located after the first ledge inside the blowhole to be protected from exposure to sunlight.

The second T&H logger (ASF 2) was installed in Quarantine Blowhole (6N-213) at the border of Western Australia and South Australia. This is to compare the temperature range with that of the more northerly lying Blowhole Cave. The rope is attached at the entrance of the blowhole with the logger on the other side lowered several metres inside the hole.

The third T&H logger (ASF 3) was installed at the end of Abrakurrie Cave (6N-3). Whilst the log book can be found on the top of the last rock pile, the logger can be found on the left wall looking towards the end of the cave.

The fourth and fifth T&H loggers (ASF 4 and ASF 5) were installed in Webbs Cave (6N-132). The ASF 4 logger was positioned in the chamber with two distinctive pillars, which is deeper in the cave and should reflect the true cave temperature. The ASF 5



Figure 2: All loggers are attached by rope so they do not touch any rocks.

logger was installed at the bottom of the entrance collapse, close to the right cave wall looking into the cave. Considerably colder air is trapped in this part in comparison to the inner cave passages or the outside temperature.

The sixth T&H logger (GIAM 6) was installed in Thylacine Hole (6N-63) which is an active blowhole several metres deep located about 10 km NW from Webbs Cave. The data collected in the blowhole will give an insight into whether the blowhole is connected to shallow cave passages (similar to Webbs Cave) or has a different, independent air circulation system.

The seventh T&H logger (GIAM 7) was installed in Madura Cave (6N-62) on the Roe Plain about 10 km S from Madura Roadhouse. It is positioned on the left cave wall (when looking deeper into the cave) 10 m into the left passage after the main channel splits in two. These measurements will provide independent data from the Nullarbor Plain.

The eighth and ninth T&H loggers (GIAM 8 and GIAM 9) were installed in Mullamullang Cave (6N-37). The GIAM 8 logger is close to the right cave wall looking into the cave close to the Smoko Junction. The GIAM 9 logger is on the right cave wall looking into the cave in the passage before The Dune. After The Dune, there is a low-roofed passage through which the air current in the cave is felt more strongly than in the large passages. The anemometer (GIAM anemometer) was installed there to measure wind direction and speed. The information about the air temperature inside the cave and at the beginning of the cave and how it correlates with the air circulation will equip us with significantly improved knowledge about the behaviour of the microclimate in Nullarbor caves.

The last and tenth T&H logger (GIAM 10) was installed in Murra-El-Elevyn Cave (6N-47). The logger is installed on the left passage side looking into the cave at the bottom of the collapse close to the underground lake. It will provide information about the variability of climatic parameters close to the underground water table.

We expect to collect the first data in



Figure 4: Caves, as always, are teeming with life. This pseudo-scorpion was found in Madura Cave



Figure 3: Anemometer in Mullamullang Cave. During our visit the wind changed from blowing into the cave to blowing out of the cave towards The Dune

a year or two (two years is approximately the life expectancy of the batteries and the memory storage capacity of the loggers). The collection of data from T&H loggers requires a USB cord with a unique Tinytag plugin at the other end, Tinytag software and a laptop (the software sadly does not work on tablets).

On the other hand, the collection of data from the anemometer does not require any software, only a simple insertion of the SD card (the micro-SD to SD card converter was left with the anemometer). However, prior to collecting the data, the anemometer logger needs to be opened manually with a screwdriver.

While this may sound a bit complicated, the overall collection of data is relatively simple; only the laptop has to be 'sacrificed' by being taken into a cave. The necessary equipment to collect data is stored and overseen by the Western Australian Speleological Group (WASG). It is meant for any Australian caving visit/expedition that would cover most of the above-mentioned caves where the loggers are installed, and

that would be prepared to spend some extra time collecting the data. If this should happen, we will advise in detail how to correctly collect the data and change the batteries. In this way, we can continuously gather data and keep the loggers working without any interruption due to flat batteries or lack of storage capacity.

Nullarbor trips and field work are usually time- and money-consuming, so we again thank the ASF Karst Conservation Fund for providing the necessary funds for scientific research on the northern part of the Plain, as well as climatic research in the caves. In addition, the work was also supported by several projects/programs through the Research Centre of the Slovenian Academy of Sciences and Arts: the European Regional Development Fund — European Union & Republic of Slovenia, Ministry of Education, Science and Sport (2017-2020, research programme OP20.01261); the Slovenian Research Agency research core funding Geography of Slovenia (P6-0101); and Infrastructure Programme (I0-0031).

We also want to thank everyone who has helped in advancing knowledge of the Nullarbor karst, especially the members of the Victorian Speleological Association who annually discover more and more karst features on the Plain, which helps to bring the big picture together; the members of the Western Australian Speleological Group for managing the equipment for data collection; Nicholas White and Robert Kershaw for support and administrative work; and Ian Collette, Ann-Marie Meredith, Robert Susac, Michael O'Leary and Milo Barham for providing equipment support, consultation and monitoring our safety in the field.



Figure 5: Sometimes you feel that crossing the Nullarbor towards the north can only be done in a good 4WD with plenty of water and security provisions. But then we met the Swag Family cycling the track between Rawlinna and Cocklebiddy. If you want to read more about their journey, they can easily be found by Googling the Swag Family

Budj Bim Cultural Landscape World Heritage Area

Nicholas White

VSA, Conservation Commission



BRETT WAKEMAN

Scouts in Airconditioner Cave, Edge of Lava Canal, Mt Eccles.

THE CAVING COMMUNITY knows the volcanic area surrounding Mt Eccles, in Western Victoria, as having a number of volcanic caves associated with the lava flows and lava canals.

These caves are quite numerous and the Southern Bent Wing Bat uses some of them. These caves are now included in the just proclaimed Budj Bim Cultural Landscape World Heritage Area.

This is a Cultural Heritage listing. Caves are not part of the listing except that they are part of the listed land. This is the same situation with respect to the caves that occurs with Jenolan which lies within the Greater Blue Mountains Area which is cited for its eucalypt forests in particular. However, the Ningaloo Reef World Heritage Area includes Cape Range and the caves form part of the listing because of their endemic biota.

In recent years there have been few Australian places inscribed on the UNESCO

World Heritage list. This is partly due to a Federal government legislative requirement that places need to be first listed under the National Heritage Legislation before they can be considered by State and Federal parties for World Heritage listing.

Budj Bim is a volcanic landscape which was modified for eel and fish farming at least 6,600 years ago by the indigenous inhabitants, the Gunditjmara.

Initial steps in the 1990s to have the area listed changed with the requirement to have the place listed first under the National Heritage provisions of the EPBC Act before it could be proposed for World Heritage listing.

Budj Bim Cultural Landscape was listed as a World Heritage Area at a meeting of the UNESCO World Heritage Committee in Baku, Azerbaijan on 7 July 2019.

The listing was in recognition of the continuous aquaculture of the eels in the waterways for at least 6,600 years by the

Gunditjmara — one of the earliest examples of aquaculture. This listing includes recognition of contemporary rights and associations of the Gunditjmara.

Budj Bim is the Gunditjmara language name for Mt Eccles. The volcanic landscape created by the eruptions resulted in lava flows, scoria cones, lava channels which have associated tunnels and caves.

The lava eruptions disrupted the existing surface drainage to the west of Budj Bim, forming Lake Condah and the associated streams. The lava flow also disrupted the drainage south of Lake Condah towards the coast, where it continues offshore.

The Gunditjmara built fish traps and weirs in the watercourses which allowed a continuous supply of eels throughout the year. This enabled a larger population to live in the area permanently. Numerous permanent stone dwellings were built near the traps.

The presence of eel traps was recorded in



BRETT WAKEMAN

Collapse Doline entrance of North Pole Cave (H-51). Cave so named because a magnetite rock at an intersection defies surveyors

1841 by the Chief Inspector of Aborigines, GA Robinson, who found 'an immense piece of ground trenched and banked, resembling the work of civilised man but which on inspection I found to be the work of the Aboriginal natives, purposefully constructed for catching eels.'

This, of course, was not what the settlers wanted to hear. These works were north of Budj Bim near Mt William. Other rivers and streams in Western Victoria have evidence of eel farming but none as extensive or with the continuous indigenous association of Budj Bim and the Gunditjmarra.

There was a massacre of Gunditjmarra at the Convincing Ground in 1833 or 1834 near Portland by whalers and sealers over disputed access to a beached whale.

The Gunditjmarra were very difficult to displace from the volcanic stony rises including those around Mt Eccles where they retreated and there was continued conflict in this part of Western Victoria between the Gunditjmarra and settlers, known as the Eumerella Wars, during the 1840s.

From 1866 an area beside Lake Condah was made an Aboriginal Reserve with a mission which was closed in 1918 to provide land for soldier settlers. Despite

this, some Gunditjmarra continued to live at the mission until the 1950s, when the mission buildings were destroyed. It was not until 1987 that the mission land was returned to the Gunditjmarra.

Dr Peter Coutts of the Victorian Archaeological Survey in the 1970s surveyed the eel traps and stone huts and discovered the vast extent of the modifications, including



KEN GRIMES

Gothic Arch Cave (H-10), Part of roofed over lava canal

trenching and stone movement, to enhance the effectiveness of water containment and capacity to entrap eels throughout the year.

Subsequent studies by Heather Builth of Monash University during the 1990s confirmed Dr Coutts' work with more detailed three-dimensional modelling of the water levels to understand the operation of the holding ponds and traps.

The acceptance of the listing as a Cultural Landscape based on aquaculture is the first such Australian listing based on the indigenous cultural aspects alone.

Other World Heritage areas have been listed for both natural and cultural heritage values.

The Gunditj Mirring Traditional Owners Aboriginal Corporation has developed a Master Plan for the Budj Bim Cultural Landscape and a number of studies inform this plan. Cultural tours are available from the centre at Lake Condah.

There are several separated areas listed as part of the Landscape; these include the Kurtonitj and Tyrendarra Indigenous protected areas.

Access facilities are in the process of being developed. Interpretation material shows evidence of eel farming.

Cave Survey Using a DistoX and the TopoDroid Android App

Stephen Fordyce

VSA

INTRODUCTION

This is intended to form a reference for those attempting electronic cave survey in the field. It is the way I have come to do it, and is by no means complete or even particularly well researched.

Electronic cave survey is not a silver bullet, nor a replacement for a thorough knowledge of manual surveying — but with a bit of practice it is a very useful tool in the arsenal of cave surveying. At this stage of development I don't think electronic cave detail sketching is practical for the sort of cold, wet, nasty caving that I mostly do.

PROS:

- No manual data entry, associated pain or chance for error
- Averaging of 3+ leg shots for higher accuracy and less error
- Data can be viewed in 3D in the cave (useful for navigation, data checking, finding existing stations, etc.)
- No pencils to break or paper data to rub off, etc.
- Data backup in-cave to microSD card-in-phone is easy; to external memory stick is also possible.

CONS:

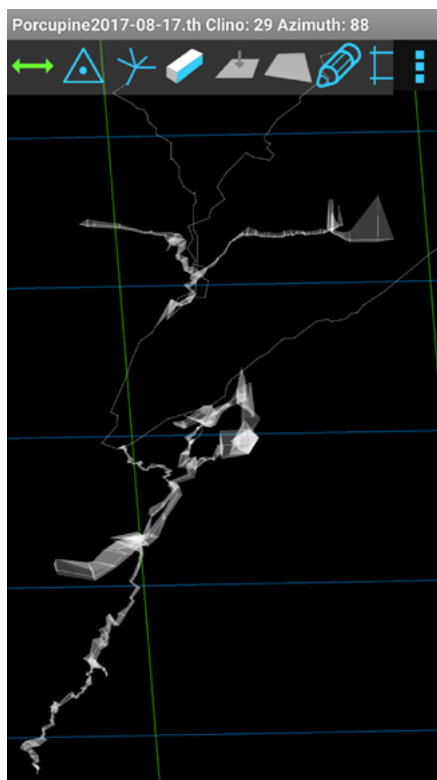
- Electronics can have flat batteries, get wet and break
- Software can do weird stuff that requires much fiddling and swearing
- Learning curve
- General unwillingness of survey helpers to sit around shivering while you play with your phone

EQUIPMENT AND RESOURCES

You'll need a few things to be successful, including:

HARDWARE

1. A DistoX or DistoX2 (there is no difference for the sake of the surveying exercise) with sufficient charge, and...
 - a. A calibration of the DistoX (local is best) — takes some time and swearing,



and is best done in a cave or away from electromagnetic interference, geographically near where you intend to survey. Allow time before you go underground or before you start surveying. Calibration guide is here: <http://www.gzluna.com/cave/distocalibnew.html>

- b. While you're there, read the DistoX manual and check all the settings are



Recommended — a waterproof case

correct (measure point from the back, etc.)

2. An Android phone or tablet with sufficient charge. I currently use a Samsung Galaxy S4 because they are common, I use them for other things, and second-hand models in reasonable condition can be had on eBay for about \$100. Using your personal phone is a bit perilous for obvious reasons. Consider a new battery, a spare battery, or a fast-charging battery bank for long sessions.
3. (highly recommended) Waterproof case for your Android device. I use the one shown, which is about \$12 on eBay. It usually lasts at least a few trips.
4. MicroSD card installed in phone — data is stored by default on the phone memory, you can back it up to the microSD card by exporting files.
5. Hard case for both — the Pelican Micro 1040 is a perfect fit for the Galaxy S4 + DistoX + a few spare pencils. I've tried cheap cases and regretted it — the Pelican Micro is pretty bombproof and reliably submersible. I got it from here: <http://tinyurl.com/yykwr6jc>
6. Carabiner for hard case and/or a bag to contain case and sketch pad
7. Sketch pad/pencils/eraser — there is sketching functionality in TopoDroid, but for now I'm sticking with traditional hand-sketching by another person.
8. What the hell, since this seems to have become a complete list, better add flagging tape and texta for marking survey stations. Anything else I missed, let me know.

SOFTWARE

Android apps to be installed, and with shortcuts dragged to convenient places on the home screen.

1. Android app installed: 'TopoDroid'.
 - a. From the TopoDroid main screen, tap 3 dots → Activity Level → Expert (or tester) for full functionality.
2. Android app installed: 'Cave3D'.
3. Android app installed/available: 'My

CAVE SURVEY USING A DISTOX AND THE TOPODROID ANDROID APP

- Files' or similar (allows you to manipulate files on the phone)
- (Optional) Android app installed: Dropbox or other to get files off the phone wirelessly.
 - (Recommended) Android app installed: 'WPS Office' or something to read .pdf and .docx files with

ADDITIONAL RESOURCES RECOMMENDED:

The good thing about having a phone is you can store lots of information on it for when you forget how to do stuff. I make a folder on my SD card and dump useful things in it — contact me at [stephen.fordyce@tfmengineering.com.au](mailto:fordyce@tfmengineering.com.au) for a copy.

- This guide.
- DistoX resources:
 - Quick reference guide (similar to manual, from <http://www.gzluna.com/cave/distoref.html>)
 - User manual
 - Calibration manual (not that useful with Topodroid, but it has interesting pictures)
- Topodroid resources:
 - Topodroid/DistoX calibration instructions (from <http://www.gzluna.com/cave/distocalibnew.html>)
- Cave maps, reports, photos or other useful info for your cave projects
- (Optional) Music for playing while surveying, while waiting for others, etc.

HELP MENUS

Topodroid has pretty comprehensive help menus that at least explain what the buttons do on each page. To access it, tap 3 dots, then Help.

BASIC CONCEPT

The concept is pretty much the same as surveying manually and writing the data down. There's a 'from station', a 'to station' a shot in between them and shots to determine the walls.

However, note that Topodroid doesn't know or care about LRUDs, it does 'Splay shots' instead. These are like LRUDs except that they can be in whatever direction you want, and you can have as many as you want*.

The between-stations shot is distinguished from the splay shots by having three or more shots close enough to be called identical.

You take all the shots for one survey point, which are stored in DistoX, i.e. in order:

- Take at least 3 (I usually do 5) shots from/to stations
- Take splay shots (I usually do 4) at the from station

- Upload the lot to Topodroid
- Check that the data has been uploaded and identified correctly
- (Optional) generate the 3D plot to see how your survey is going!

* I recommend sticking with four splays in roughly LRUD directions at least initially. Otherwise the onboard viewer can go a bit weird and exporting to Compass generates LRUDs and discards the rest anyway. Or you can have all the splay shots in Compass but then the LRUDs and Compass 3D display are weird.

PAIRING THE DistoX

- Make sure the DistoX is on, and has Bluetooth enabled
- Make sure Bluetooth is enabled on the Android device
- Open the Topodroid app
- Tap the Disto icon
- (or something) Tap 3 dots, and select 'scan'
- (or something) Tap 3 dots and select 'pair'
- The pairing code if required should be 0000 or 1234
- You can tap and hold or something, to name the DistoX so you know which one it is
- If you're having trouble, make sure Bluetooth is enabled on both your Android device and on the DistoX

STARTING A NEW SURVEY

- Open the Topodroid app
- Tap the plus button and fill out the details (leave the checkboxes as they are)
- In between 'Team' and 'Magn. decl.' is the default station name prefix
- Tap 'Open' or 'Save'
- You'll then be able to tap on the survey from the home screen to enter it
- Open the survey and check the settings (tap 3 dots → Settings), especially:
 - Stations policy: Forward leg, splays
 - Units: metres, decimal degrees

IMPORTING A SURVEY

It's very nice to have the existing survey loaded, even if you don't intend to add to it, so you can see the cave in 3D as you go. And adding to it is extremely useful because you can see in real time what the cave is doing.

- Put the correct survey file in the correct location on the Android device.
 - For a single consolidated .dat Compass data file with file name matching survey name, put it in Local Device → Device Storage → Topodroid → dat
 - For a Topodroid .zip file (ie. from someone else), put it in Local Device → Device Storage → Topodroid → zip

- Open the Topodroid app.
- Tap the 'import' button (box with arrow)
- You should get a list of importable surveys — tap the one you want and follow the prompts.
- More detail...?
- View it in 3D and check that everything is there.

EXPORTING A SURVEY

Necessary to see the data in Compass, or to 'save as' for backup purposes.

- View the survey in Topodroid
- Tap 3 dots → Survey Info
- Tap 3 dots → Export
- Select export type (ZIP is the native Topodroid — use for backups, Compass is, well, for Compass) and tap Save
 - i.e. for Compass (.dat data file): Local Device → Device Storage → Topodroid → dat
 - i.e. for Topodroid (.zip file): Local Device → Device Storage → Topodroid → zip
- You can then use the 'My Files' app or similar to copy/move to Dropbox, to the phone microSD card etc.
- Or plug the phone into a PC via USB and access that way

BACKING UP A SURVEY

Up to you how often this gets done! Obviously if the phone dies it's much harder to get to the memory than the microSD card, which can be popped out. Do this immediately if the phone is flooded to prevent corrosion.

Maybe try installing Topodroid on the microSD card instead of the phone memory. Or back up to the microSD card at regular intervals.

- Export your survey as described in that section.
- Use the 'My Files' app to transfer to the phone uSD card.
- For an external USB stick, you'll need a 'USB OTG' cable as well.

ADDING TO A SURVEY

Basic shot-taking:

- In my experience, a three-person team is good — sketcher, station picker and instruments. The person on instruments deals with both DistoX and Android devices.
- You can do a manual entry by tapping the plus icon — this is useful for dummy shots, branches or tie-ins.
- Check that there are no shots stored in the DistoX (little number in the top right screen corner, absent if 0). Clear

CAVE SURVEY USING A DISTOX AND THE TOPODROID ANDROID APP

Porcupine2017-08-17

PX28	PX29	1.72	115.9	4.6	[>]
PX29	PX30	1.22	159.0	-13.1	[>]
PX30	PX31	4.92	180.5	-1.1	[<]
PX31	PX32	3.82	199.3	-3.1	[<]
PX32	PX33	3.28	186.3	-4.4	[<]
PX33	PX34	1.68	158.6	20.0	[>]
PX34	PX35	5.01	209.2	3.3	[<]
PX35	PX36	4.68	179.3	-1.6	[>]
PX35		0.60	118.8	5.3	[]
PX35		1.91	314.0	4.3	[]
PX35		3.84	86.5	78.0	[]
PX35		1.40	185.3	-83.5	[]
PX36	PX37	3.93	149.2	16.9	[>]
PX37	PX38	4.06	115.1	25.1	[>]
PX38	PX39	8.51	124.0	0.2	[>]
PX39	PX40	2.99	142.7	-11.7	[>]
PX40	PX41	12.34	108.5	-5.6	[>]
PX41	PX42	7.60	129.9	-11.4	[>]
PX42	PX43	5.80	102.6	15.6	[>]
PX43	PX44	10.57	127.4	-1.4	[>]
PX44	PX45	6.39	103.8	0.9	[>]
PX45	PC36A8	5.11	157.4	-19.3	[>]

Screenshot — adding to a survey

memory by pressing and holding Clear and Units.

- Take at least three (I usually do five) DistoX readings of FromStation→ToStation, then take your splay shots (I usually do four, roughly LRUDs). The DistoX shot count should then read 9.
- Go to the phone with TopoDroid and the current survey open.
- Tap the download button (bar with arrow, top left) and you should see the DistoX count down as the shots appear in TopoDroid. The identical ones should be consolidated and collapsed into the shot, and the splays, with some colour schemes. The station name is incremented automatically. You may need to delete any shots meant to be contributing to the leg but not recognised as identical.
- Tap on the station name to expand its splay shots (these are shown with a blank 'to' field — see station PX35 in the screenshot for an example).

If you find that your three 'identical' shots are often not being registered as such and/or you are spending a lot of time deleting and re-doing data, you can either find a less hypothermic DistoX operator or change the settings to allow more tolerance of the three-shot grouping.

It's possible to take a whole lot of these groups and store them in the DistoX, dumping the lot in and letting it get sorted out automatically.

We did this once for about 10 shots when the phone went flat.

This is a bit perilous when trying to

troubleshoot any shots that were messed up, but we got away with it that time.

BRANCHING A SURVEY

I do this by making a manual entry. Tap the plus button to add a manual dummy shot from the branch station to another station very close, with the station prefix/number you want for the branch — remember that TopoDroid will automatically increment it next shot. LRUDs for the dummy shot are nice for consistent display in 3D

i.e. For A1 → A2 → A3 → A4, and I want to branch off from A2, to stations B1, B2, etc.

My manual dummy shot will be A2 to B1, 0.1m, 0deg, 0deg (or aim the DistoX at a close rock and hold it very steady). For all intents and purposes, A2 and B1 are the same station. The first real shot via the DistoX down the B branch will be B1→B2.

IMPORTANT: if you mess up the naming convention, you will have to edit or delete all of the splay shots in the subsequent collection.

IMPORTANT: after any branch or tie in, do a few legs and check in 3D that things look correct before you get too committed.

TYING INTO AN EXISTING SURVEY

Same as for branching a survey; do a manual dummy shot to connect.

DELETING SHOTS

OK, this is now a whole lot easier — we used to have to delete each splay and leg shot individually. (Possibly this is related to selecting the 'Expert' user level) Now, if you tap and hold over the shot, a new menu comes up, with the red cross meaning 'delete.' You can select multiple shots if expanded to show splay shots, or if not expanded, the splay shots are automatically deleted with the leg shots.

COMBINING SURVEYS

I haven't figured out how or needed to do this yet, and I don't think it's possible in Topodroid. Possibly there is a higher level app — 'Therion' or a variant(?) that does this.

3D PLOTTING

The cool bit. Seriously, this is incredibly cool. Did I mention how cool it is?

- You'll need the 'Cave3D' app to render it, although you don't ever actually open it yourself. (TopoDroid accesses it.)
- You'll need to have your survey open in TopoDroid.
- Tap 3 dots → 3D, and you should get a line plot.
- It defaults to 3D rotation — use one finger to rotate, two fingers to pan and zoom.

- Or tap the round arrow at top left to lock rotation and just pan/zoom
- Dot-in-triangle toggles station names on/off
- Sticks toggles splay shots/dots/off
- To show the walls, tap 3 dots → Wall models, and select Powercrust
- Then tap the 3D rectangle to toggle the walls display on/off (you can still toggle splay shots, station names, etc.)

So cool... Apart from checking that your data is correct and for navigating/seeing what the cave is doing, it's also useful for figuring out where to tie into stations that might not be marked but which are obvious.

Yes, you have to select the wall models/Powercrust thing each time, or at least I haven't figured out how to avoid it.

TIPS, TRICKS AND MISTAKES TO AVOID

- Practice somewhere warm and easy with tolerant companions. Do dummy shots for marked stations, branches and tie-ins. It's actually quite possible to survey solo.
- Set up your survey in the phone before going into that horrible wet, cold cave
- Turn the phone to flight mode to prolong battery life a lot. You should still get a prompt to allow Bluetooth when starting the TopoDroid App
- Turn the phone screen brightness as far down as possible to save battery
- Read the manual and learn all the options for your DistoX. Here's a few reasons why:
 - You want to delete a bunch of shots instead of having to upload them into the phone. (A dummy project is another, less effective way of dealing with this.)
 - You want to check the battery voltage to see whether to bother charging it before a trip
 - You accidentally put it into backsight mode and collect a whole lot of backwards data
 - You turn Bluetooth off and spend a lot of time swearing at the phone when it won't work
 - You measure from the wrong place
- Remember, if you get stuck, to navigate to your resources folder on the phone and read the instructions if you need to. Also check the help option in each TopoDroid screen.
- For each new survey, double check that the correct stations policy is selected, and that the plot is looking OK in 3D after your first few shots.
- For branches, tie-ins, or anything else weird, check the 3D plot sooner rather

- than later, before you get along too far.
9. Try to keep your splay shots a consistent number, direction and order — it's probably best to stick with roughly LRUDs. You can vary the points to show the shape of the passage better, or to define a large room, but the plot can go weird if you start to get inconsistent. Also bear in mind that if you are exporting to Compass, LRUDs will be automatically calculated from the splay shots, so your sideways-sloping rift passage will become a barrelling master cave if you're not careful.
 10. That said, there is an option to export the splay shots as L-flagged (not counted in cave length) into Compass, so you could use the splay shots to collect very accurate cross-sections if you're prepared to make sense of the data later.
 11. Calibration Mode: it's relatively easy to be fiddling around in TopoDroid without reading the instructions and put the DistoX into calibration mode. The good news is that even if you take

test shots with the DistoX, it's quite hard to screw up the calibration. Clear the DistoX memory and toggle out of calibration mode by pressing button in TopoDroid (two arrows chasing each other in a circle).

12. Rather than trying to add notes about survey stations, I use the following conventions (in addition to marking on sketches):
 - a. Dummy shot 0.1m (i.e. two survey stations stupidly close together) indicates a station marked with no label.
 - b. 2 dummy shots 0.1m (i.e. three survey stations stupidly close together) indicates a station marked with a label
 - c. Whatever you do, record it with the survey data afterwards so future cavers will tear out slightly less hair.
13. If you find that your three shots are often not being registered and you are spending a lot of time deleting and re-doing data, you can either find a less hypothermic surveyor or change the

settings to allow more tolerance of the three-shot grouping.

FINAL REMARKS

Well, that turned into a bit of an epic. Hopefully I haven't reinvented the wheel, but this is all stuff I had to figure out for myself. If you have comments, edits or anything else, please feel free to make them with tracked changes so I can update the document.

If you find a better way to do anything, let me know: stephen.fordyce@tfmengineering.com.au

Marco, the programmer of TopoDroid, is receptive to bug reports and suggestions — you may have noticed the 'dive data entry' checkbox; that's in response to a request of mine. I think he's done a pretty amazing job on the app, and it continues to be updated regularly.

You can find more information on the TopoDroid website:

<https://sites.google.com/site/speleo-apps/home/topodroid>.

Review

Offline GPS Navigation and Satellite Imagery on Android Smartphone

Steve Milner
CEGSA

AFTER TRYING numerous map apps for my smartphone, I have finally settled on one that meets all requirements: it really works offline, has tracking and excellent waypoint management.

The app 'Australia Topo Maps' is one of a series made by ATLOGIS Geoinformatics GmbH & Co. KG who produce a wide range of GIS products for use all over the world.

After downloading the free version from Google Play to try it out, I then paid a whopping once-off fee of just over \$18 for the pro version to allow import of waypoints and an unlimited cache of maps (subject to smartphone memory availability), and accessibility to other features.

As most of my intended use was to be on the Nullarbor where there is very little mobile reception, a genuine offline capability was essential for a GPS navigation tool. Australia Topo Maps proved to have this capability.

The app is intuitive to use and is a very practical addition to the normal complement of navigational tools such as the tra-



ditional compass, paper map, odometer, or old-school GPS units, and common sense!

The app comes complete with a bundle of map layers, but I quickly downloaded a geological map, NATMAP Topo maps and tiles from ESRI Aerial to meet my needs. Downloading ESRI Aerial is data-hungry ... detailed satellite imagery of a few hundred square kilometers can be several gigabytes, so plan your trip and download before you leave home.

My only gripe was loading GPX waypoint data to my smartphone; the process was unreliable until I used a USB cable for the task.

The app was tested thoroughly on two recent Nullarbor expeditions, and has proved to be very reliable. All waypoint and track data from the trips were easy to manage and review on a computer back at home.

All in all, a very handy navigation and cave finding tool. Five stars.

Note: Beware, do not rely upon your smartphone for navigation alone as such technology can fail.

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support over the year. Have
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