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FRONT COVER: Conference delegates in Te Anaroa Cave, Aorere Valley NZ, photo Neil Collinson

BACK COVER: Te Anaroa Cave, Aorere Valley NZ, photo Arthur Clarke

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IN THIS ISSUE

We recognise the traditional people of the lands of all our members and editorial contributors.

ACKMA acknowledges the Traditional Owners of the land on which we meet and work, and all Traditional Owners of country throughout Australia. We recognise Aboriginal and Torres Strait Islander peoples' continuing connection to land, place, waters, and community. We pay our respects to their cultures, country, and elders past present and emerging.

ACKMA recognises the unique role of Māori as Tangata Whenua and embraces Te Tiriti o Waitangi recognising Māori as tino rangatiratanga of Aotearoa/New Zealand while embracing the three guiding principles of the Treaty – Partnership, Participation, and Protection. We will endeavour to implement bicultural policies and practices that incorporate and value Māori cultural concepts, values, and practices.

Editorial

Kirsty Dixon

Welcome fellow ACKMAites,

I am pleased and honoured to be re-elected as the ACKMA Journal editor (I am ignoring the fact there were no other nominations!). I am trying some new formatting options in this journal as some people have indicated that they were having trouble reading the prior formats. I would be very grateful for any feedback on these changes!

First and foremost, hearty congratulations to the Tākaka Conference Organising Committee for what we hear was a fabulous conference in a spectacular location! Unfortunately, there was not sufficient time for delegates to compose any detailed reports, but hopefully there will be more in the September journal. If you have photos you would like to share, please contact Rauleigh Webb at webmaster@ackma.org .

Secondly, I wish to thank those contributors who were patient with the publication of their submissions from the December journal – I am most grateful, and hopefully everyone will appreciate your contributions even more this time around.

We have a few changes on the ACKMA Committee this year. We say farewell and thankyou to Shannon Corkhill. A big thankyou to Scott Melton for his efforts as Australian Vice President and we are very glad that he will still be participating as a Committee Member. Dave Gillieson has moved from Committee Member to Australian Vice President, and we are exceptionally grateful for his skills and experience. We also welcome Jill Rowling as a new Committee Member and look forward to a new perspective and input into Committee matters. For those of you who may not know Jill, she is a caver from NSW and also an ASF member and has been active in several submissions on karst issues recently. It is also very heartening to see so many of the old Committee standing again, so thankyou to all of you too!

You may notice that there are a few formatting changes in this issue, as Rauleigh Webb particularly wanted the graphs for the Cave Climate update to be visible in landscape format, so they could be more easily read. If you still wish to print the journal out, these pages should auto-format, but if you have any difficulties, please let me know and I can send you a pdf with those pages rotated to a portrait view.

Finally, I wish to express my sincere gratitude to those people who send in contributions to the journal. We have a wide variety of interests and experience in ACKMA, and it as great to see that being shared. I should have several international trips being reported for the next journal and will happily accept any other contributions.

An especial note of gratitude to Rauleigh Webb and Andy Spate for proof-reading this document in an extremely tight timeframe, so it could be completed before I went away!

Kind regards, Kirsty

ACKMA Presidents Report
Ian Eddison

This report was tabled at the ACKMA AGM in Takaka, May 2023

It is pleasing to be attending an ACKMA conference in person, especially in New Zealand. I submit my report to our AGM - the year 2022–2023. I value the contributions of our executive and those active members that become involved on issues.

Cave tourism sites across Australasia have had to adapt to opening with new staff and some are still dealing with redevelopments and access. There have been major storms very recently that were cause of concern in New Zealand and there continues to be recovery and revised developments in various caves sites in the southeast of Australia. These were repercussions of past fires, floods and landslips etc.

As we meet in conference in Takaka New Zealand I am pleased to say that your committee contributed $10,000 to the Greenlink land purchase at Takaka. This is a NZSS project to secure an important catchment in this area of New Zealand.

A Memorandum of Understanding (MOU) with the NZSS is being sought and our template is that established with the ASF. More detail will be worked on with the NZSS and we hope to finalise this in the near future. A positive relationship between ACKMA and the ASF as well as the NZSS has been evolving. An MOU sets the formal framework for these relationships.

The International Year of Caves and Karst was extended to a two-year event 2021 - 2022 due to many international events not being able to occur because of the pandemic. So, while that event did wind up late last year, it continues to be appropriate to continue to educate and promote the themes 'explore, understand and protect' in all our natural and developed cave and karst areas in Australasia.

You will have observed changes to the appearance of our journal courtesy of the current editor Kirsty Dixon. We made changes from continuing with design by our previous printer however while that relationship was a positive one, we made change to save design production costs. I trust you are enjoying the proactive editorial changes by Kirsty and if you have contributions, please contact her. Thank you, Kirsty.

Our ACKMA web site was down for a lengthy period due to our provider and Rauleigh Webb was heavily involved in rescuing our site. Thank you Rauleigh.

Rauleigh was also involved in the instigation of our cave climate monitoring program along with the committee on that Andy Baker, David Gillieson and Andy Spate. I wish to acknowledge them and people on sites conducting this wonderful project. It is fascinating how we can demonstrate each cave is unique and the impact visitors make on our caves. This project continues and a current opportunity exists if cave tour sites that were not previously contributing to possibly join in.

Brian Clark has represented us at the Australian Fossil Mammal Site, Naracoorte Inter-agency Community Reference Group. Thank you, Brian.

ACKMA was excluded from a Jenolan Caves stakeholder group however along with the ASF we have since been involved with a Grand Arch Precinct Plan and a flood management survey. We also have commitment for ACKMA to hold a future conference at Jenolan Caves.

The Mt Etna Caves at Rockhampton required meetings to be attended and submission to be prepared. This well-known conservation battle of the past raised its head again due to further quarrying proposed by the operator. ACKMA responded and lodged concerns with the Livingstone Shire Council as well as the Queensland Government.

Green energy raised its head as a conflict with caves and karst in the Nullarbor which is huge and there may yet be other issues on other karst areas around the country. ACKMA is supportive of the green energy developments, but we need to remain vigilant and constructively help prevent issues conflicting around caves and karst with these developments. Arrowsmith is another in WA. It is important to remain aware where projects are on or near karst catchments. This is our biggest ongoing concern currently.

A revision of the Hills of Gold Wind Farm, (Near Timor caves NSW) has meant a win for vegetation cover and some distance has been gained from turbines from nearby craggy outcrops and caves.

Kosciuszko National Park required significant input from ACKMA. There have been various proposals responded to but ongoing concern is feral horses. Thanks to several of our committee and especially Andy Spate and John Brush on this.

Sixteen Legs -the travelling exhibition through Bookend Trust has now wound up. What a wonderful interpretation of life in caves this has been. Especially cave spiders. I acknowledge the Bookend Trust and the team which covered great distances in Australia to engage communities on the subject of life in caves.

I would like to acknowledge Cathie Plowman for her work on Cave animal of the year and the ASF's Cave Cricket newsletter. Both are wonderful programs. Thank you, Cathie.

Cave tourism site restoration work continues for cave tourism sites following devastating bushfires and flooding. These include Abercrombie Caves, Jenolan Caves, Wombeyan Caves, Buchan Caves, Kelly Hill Cave and Margaret River caves. We wish them all success in their redevelopments and hope these very unfortunate events present opportunities to plan and develop for the future needs of tourism balanced with future environmental considerations.

EcoGuide Certification by Savannah Guides remains an excellent training option for cave tourism sites. In particular, a plan is being formulated for our 2027 conference at Chillagoe Caves and Savannah Guides will take a lead role with the intention of incorporating the EcoGuide training for cave guides.

The National Rock Garden in Canberra hope add a specimen from Naracoorte caves and our committee has agreed to support this and fund the plaque to accompany it.

Anita and I attended the Australasian Bat Society conference in Brisbane in 2022 which was very well run. There were a few cave-connected people participating too. Over the years I have found it very helpful to my continued learning by participating in events related to caves and karst and recommend to you to join in the areas that interest you. On that note here are some important groups/conference dates you may want to consider:

Interpretation Australia conference will be held on 9 November 2023 in Sydney. AAEE Australian Association of Environmental Educators 25-27 September 2023 in Wollongong.

Interpretation Network New Zealand (INNZ) https://www.interpretationnz.co.nz/ for some great blogs for all, not only New Zealand based interpreters.

Indigenous involvement in cave management is important to ACKMA and we aim to respectfully interact with the first nations people of regions we engage with. We aim to be good ambassadors for our traditional people's rights and work cooperatively on cave and karst issues. In addition to the Green Energy challenges, ACKMA has continued liaison with ASF on this but also the damage to art in Koonalda Cave. Media by ASF certainly raised the lack of security at the site and resulted in better protection in the future.

Late in 2022 the Australian State of the Environment Report was released, and it includes caves and karst. Thankfully our landscape is acknowledged in this critical document.

ACKMA has formally commented (neither supported nor rejected) on the Regis Gold Mine proposal at Kings Plains near Blayney NSW. We made the point that the risk to Cliefden Caves is real if poor judgement in management of tailings dams and major rain event occurs. The fact that other gold mines (Cadia) are being managed closer to Cliefden Caves was a part of the advice to us. We incorporated elements from the State of the Environment Report in our formal comment. This mine has now been conditionally approved.

LED lighting is an important part of show caves these days, but we are now aware of the problems with certain spectrum of light and the depletion of cave fauna. You would note the talks online and articles within our journals. Please make contact if you are considering any new lighting in show caves so you are pointed in the right direction before you make your commitments to infrastructure. Thank you to Liz Read for leading research on this.

I am pleased to announce that it is planned to have conferences at the following sites in the future:

2025 Wellington Caves NSW; 2027 Chillagoe Caves QLD; 2029 Jenolan Caves NSW. We remain open to additional activities from time to time, online or in person, and especially on the alternate years.

I pay my respects to the traditional custodians of the land where I live, work and engage in.

Ian Eddison

Elery Hamilton Smith Award 2023

The Elery Hamilton-Smith Award is given for the most meritorious article published in the ACKMA journal over the preceding two years. The award is normally given in association with the bi-annual conference, but with the postponement of the Tākaka Conference in 2022, it was decided that as the journal editor was retiring, the award should still be made in 2022. It was awarded to Grant Gartrell for his article "In the blink of a magic eye", ACKMA Journal # 126.

With the 2023 Tākaka Conference proceeding, it was decided that the EHS Award should be given again to be in alignment with future conference years, hence it considered some articles overlapped from the previous award considerations.

It is judged according to the following criteria:

- Contributing to the management of cave and karst resources,
- Promoting the ideals of ACKMA,
- Inclusivity and relatability to those working in the management of caves and karst,
- Ease of readability and relevance to the general membership.

The 2023 recipient submitted well-written and easily understood articles that were broken into bite-sized sections with catchy titles. The articles educated the reader and provided relatable examples that aimed to stimulate thought about active management issues.

I offer my sincere congratulations to Grant Gartrell (again!)

Cave Climate Graphs on the ACKMA Website V3

Rauleigh Webb, Andy Baker, Dave Gillieson, Andy Spate and Rob Susac

During 2020 ACKMA instigated the deployment of data loggers to a number of cave sites throughout Australia and New Zealand. This was an attempt to capture the best baseline climate data for all these caves, as visitation to the caves had been halted due to COVID-19 restrictions. The data collected currently starts from the 28/05/2020 and runs to 13/02/2023. Overall, the maximum number of data records is 126210 with Yonderup Cave at Yanchep WA providing the most continuous data set so far.

The ACKMA Cave Climate Graphs web page shown in *Figure 1* has changed dramatically since 2020 as data has continued to be provided from the ACKMA data loggers from many of our collaborating sites. The graphs have had to be separated down to a maximum of two years of data display because the internal & external temperature graphs could not be displayed once the number of data points past the 80,000 mark - so for each site the available data years is calculated each time the data is updated and only those years with available data for each site are displayed on the ACKMA Cave Climate Graphs web page.

The links page is shown below in *Figure 1* and is at https://ackma.org/CaveClimate/index.asp .

When the Temperature, Relative Humidity or Internal/External links are clicked on, then the relevant graph is prepared by loading the data from the website and generating the graph.

An additional change has been made in the graph displays relating to the date on the X axis which is now displayed weekly for single year graphs and monthly for two-year graphs. The time is now displayed in military time with a 24-hour clock.

Each 10-minute data point is tagged individually so as you move your cursor over the graph you can see the date and time of the point as well as the temperature or relative humidity value. Note also that the smallest temperature measurement recorded by the data loggers is 0.1 °C.

Examining the Yonderup Cave Highest Temperature Fluctuations

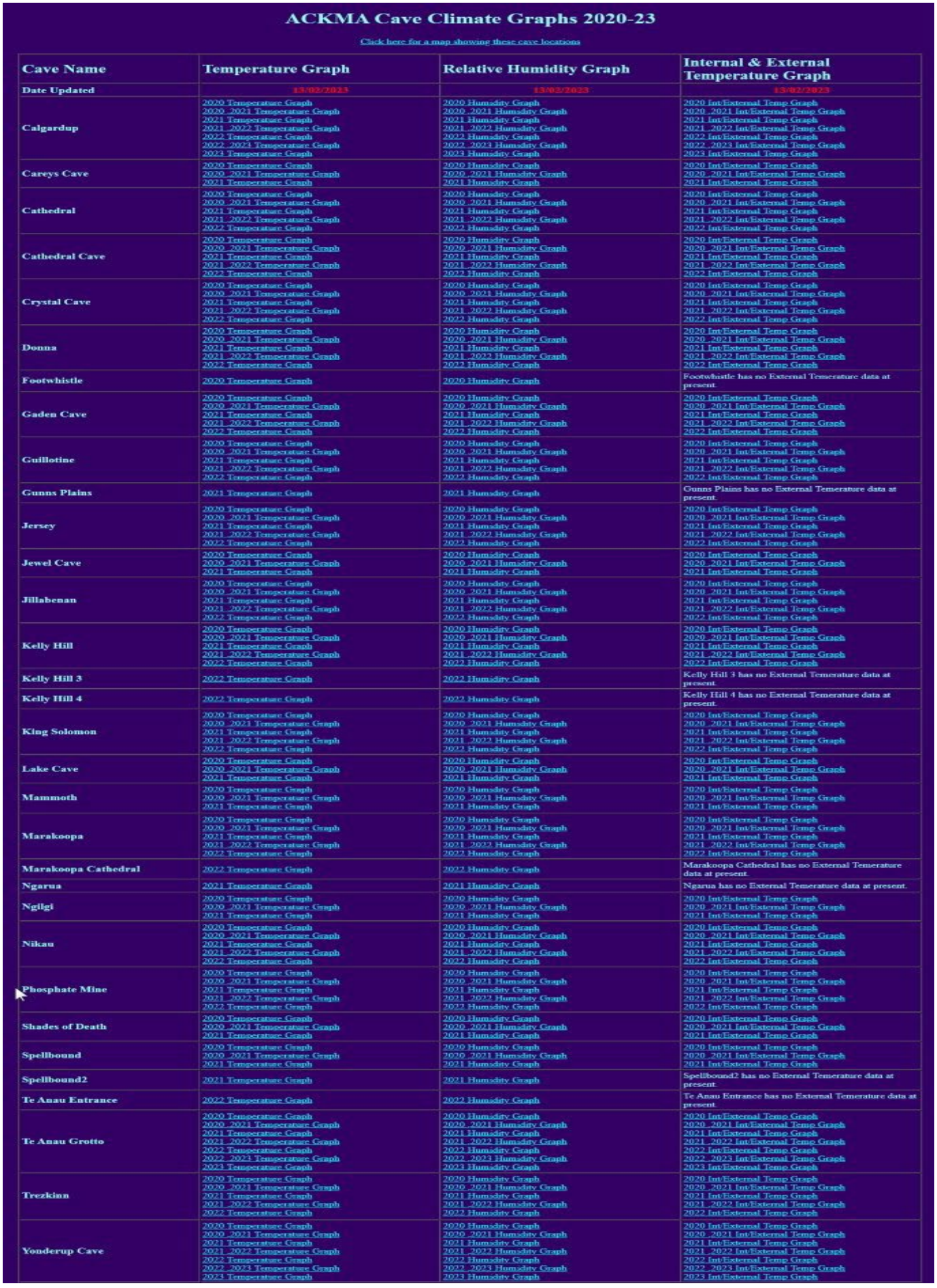
Using the zoom feature of the graphs the five highest temperature peaks were examined over the 2020-22 data sets for Yonderup Cave.

Table 1 shows the start times and temperatures of the peaks until the temperature returned to the starting temperature. The zoomed view of the first peak on the 11-Aug 2020 is shown below in *Figure 2*. It is labelled with the Start, Peak, Close and Return to Start Temp points used in all of the peaks examined for Yonderup Cave.

These five highest temperature peaks were thought to be related to cave visitations. However, when visitation data was compared to the dates of the five highest peaks only one correlated to a cave tour which consisted of only 3 people.

Rob Susac suggested that the peaks may relate to visits by rats, whose scats were being found in the cave and it became apparent that there had been an increase in rat activity. The logger is less than 0.5m off the floor of the cave and easily climbed by a rat.

Rob also indicated that visitors to the cave passed closely by the logger (less than 1m) as it is by the only path next to the display of gypsum crystals which is a feature of the tour. The tour group generally takes about 30 minutes to reach the data logger location from the tour start time. The tour guide generally stops near the data logger (approximately 0.5m away) while talking to the tour group. Visitors may also linger around the data logger while viewing the nearby gypsum or other features. The tour group also returns past the data logger location about 10 minutes later as they depart the cave. The tour guide does not typically pause at the data logger on the way out.



ACKMA Cave Climate Graphs 2020-23

Click here for a map showing these cave locations

Cave Name	Temperature Graph	Relative Humidity Graph	Internal & External Temperature Graph
Date Updated	13/02/2023	13/02/2023	13/02/2023
Calgardup	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph 2022_2023 Temperature Graph 2023 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph 2022_2023 Humidity Graph 2023 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph 2022_2023 Int/External Temp Graph 2023 Int/External Temp Graph
Careys Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Cathedral	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Cathedral Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Crystal Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Donna	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Footwhistle	2020 Temperature Graph	2020 Humidity Graph	Footwhistle has no External Temerature data at present.
Gaden Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Guillotine	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Gunns Plains	2021 Temperature Graph	2021 Humidity Graph	Gunns Plains has no External Temerature data at present.
Jersey	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Jewel Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Jillabenan	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Kelly Hill	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Kelly Hill 3	2022 Temperature Graph	2022 Humidity Graph	Kelly Hill 3 has no External Temerature data at present.
Kelly Hill 4	2022 Temperature Graph	2022 Humidity Graph	Kelly Hill 4 has no External Temerature data at present.
King Solomon	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Lake Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Mammoth	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Marakoopa	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Marakoopa Cathedral	2022 Temperature Graph	2022 Humidity Graph	Marakoopa Cathedral has no External Temerature data at present.
Ngarua	2021 Temperature Graph	2021 Humidity Graph	Ngarua has no External Temerature data at present.
Ngilgi	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Nikau	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Phosphate Mine	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Shades of Death	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Spellbound	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph
Spellbound2	2021 Temperature Graph	2021 Humidity Graph	Spellbound2 has no External Temerature data at present.
Te Anau Entrance	2022 Temperature Graph	2022 Humidity Graph	Te Anau Entrance has no External Temerature data at present.
Te Anau Grotto	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph 2022_2023 Temperature Graph 2023 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph 2022_2023 Humidity Graph 2023 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph 2022_2023 Int/External Temp Graph 2023 Int/External Temp Graph
Trezkinn	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph
Yonderup Cave	2020 Temperature Graph 2020_2021 Temperature Graph 2021 Temperature Graph 2021_2022 Temperature Graph 2022 Temperature Graph 2022_2023 Temperature Graph 2023 Temperature Graph	2020 Humidity Graph 2020_2021 Humidity Graph 2021 Humidity Graph 2021_2022 Humidity Graph 2022 Humidity Graph 2022_2023 Humidity Graph 2023 Humidity Graph	2020 Int/External Temp Graph 2020_2021 Int/External Temp Graph 2021 Int/External Temp Graph 2021_2022 Int/External Temp Graph 2022 Int/External Temp Graph 2022_2023 Int/External Temp Graph 2023 Int/External Temp Graph

Figure 1: Cave Climate linkage page from the ACKMA website https://ackma.org/CaveClimate/index.asp

Year	Date	Data	Start	Peak	Close	Return to Start Temp	Total Time
2020	11-Aug-20	Time	15:29	15:49	16:29	17:29	2:00
		Temp °C	17	18.2	17.1	17	
		Temp Diff °C		**1.2**	**-1.1**	**-0.1**	
2020	25-Aug-20	Time	10:59	11:19	11:59	12:19	1:20
		Temp	16.8	17.5	16.9	16.8	
		Temp Diff °C		**0.7**	**-0.6**	**-0.1**	
2021	5-Jun-21	Time	14:47	14:57	15:27	15:47	1:00
		Temp	17.2	17.9	17.3	17.2	
		Temp Diff °C		**0.7**	**-0.6**	**-0.1**	
2021	31-Jul-21	Time	13:57	14:07	14:37	15:07	1:10
		Temp °C	17.1	17.8	17.2	17.1	
		Temp Diff °C		**0.7**	**-0.6**	**-0.1**	
2022	25-Nov-22	Time	9:57	10:07	10:27	11:07	1:10
		Temp °C	17	17.5	17.1	17	
		Temp Diff °C		**0.5**	**-0.4**	**-0.1**	

Table 1: Yonderup Cave five top temperature fluctuations 2020-22

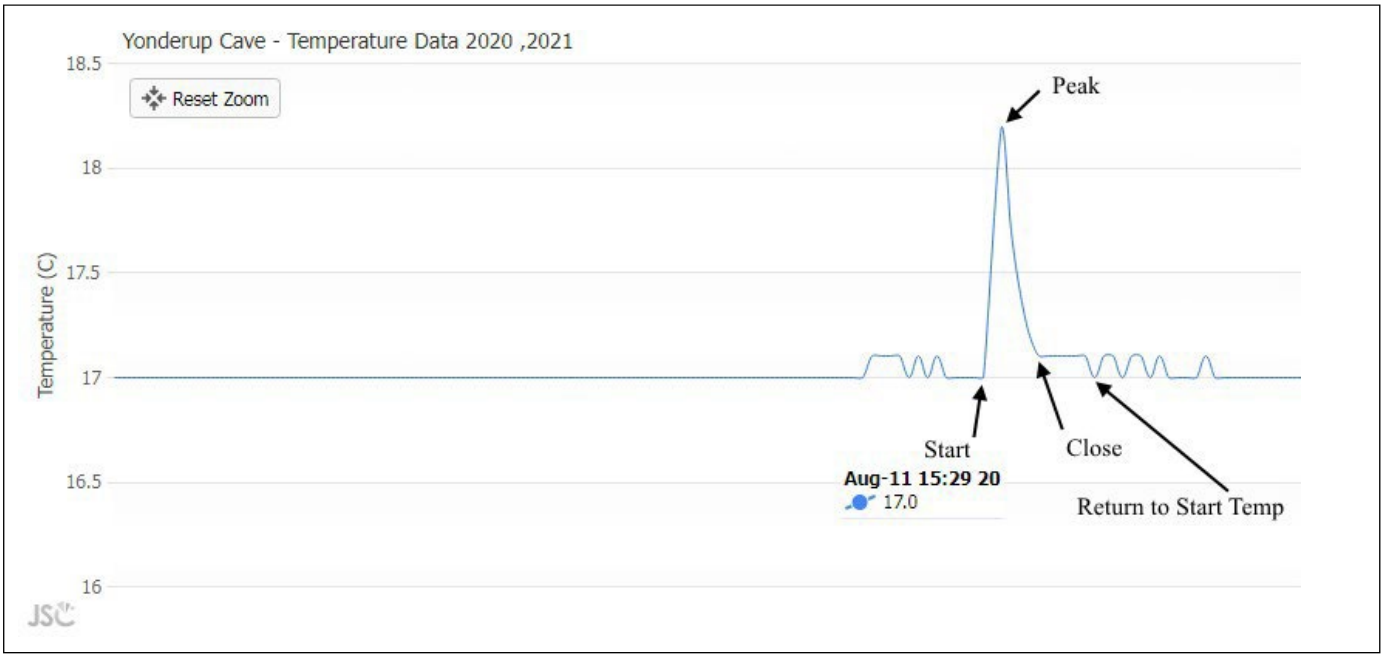


Figure 2

Examining the Yonderup Cave Temperature Fluctuations on Tour Dates

The dates and times of tours undertaken in January 2023, which started on the 19th January, were examined on the dates that tours occurred until the 30th January 2023.

Yonderup Cave Tours January 2023																
Date	Tour Time	No of Visitors	Temperature Variation ˚C	Return Time mins	Tour Time	No of Visitors	Temperature Variation ˚C	Return Time mins	Tour Time	No of Visitors	Temperature Variation ˚C	Return Time mins	Tour Time	No of Visitors	Temperature Variation ˚C	Return Time mins
19/01/2023					10:30	3	0.1	40	13:00	8	0.2	100				
20/01/2023					10:30	4	0.1	50	13:00	5	0.2	Did not	14:30	6	0.1	120
21/01/2023					10:30	6	0		13:00	11	0.1	30	14:30	4	0.1	20
22/01/2023					10:30	8	0		13:00	9	0.2	30	14:30	11	0.2	60
23/01/2023					10:30	5	0.1	40	13:00	11	0.1	50	14:30	4	0.1	50
24/01/2023									13:00	6	0.1	50	14:30	4	0.1	40
25/01/2023	9:30	4	0.1	60									14:30	4	0.1	50
26/01/2023	9:30	3	0.1	20	11:00	9	0.1	70	13:00	9	0.2	Did not	14:30	10	0.1	30
27/01/2023					11:00	9	0.1	80	13:00	11	0.1	20				
28/01/2023					11:00	9	0.1	50	13:00	10	0.2	80	14:30	7	0.1	90
29/01/2023									13:00	9	0.2	40	14:30	6	0.2	50
30/01/2023					11:00	7	0.1	50	13:00	5	0.1	20	14:30	4	0.2	40

Table 2: Yonderup Cave Tours January 2023

Cave tours did occur on the 31st January 2023 but the data from the data logger has not yet been submitted.

As January is generally a hot month it is expected that the overall air temperature of the cave should rise over this period.

Yonderup Cave Tours 19/01/2023

Two tours were conducted on the 19/01/2023 at 10:30 (3 visitors) and 13:00 (8 visitors). The temperature data for Yonderup Cave on the 19/01/2023 is shown in *Figure 3*. The rise of 0.1°C from the current daily base temperature of 17.5°C, starts at 10:56, approximately 30 minutes after the tour starts, and returns to the base temperature at 11:36. The return time is shown in Table 1 as 40 minutes.

Then there are four 0.1°C fluctuations before the 0.2°C rise at 13:26 caused by the 13:00 tour. The return time on the 13:00 tour is 100 minutes which is probably due to the larger group size resulting in a longer time before the daily base temperature is reached. It may also be longer as the base temperature is on the rise as well.

Note also the flat line 17.5°C during the night and then the start of the 0.1°C fluctuations during the day. These fluctuations appear to be the precursor to the overall base temperature rise to 17.6°C which occurs on the 20/01/2023.

Figure 3.

Yonderup Cave Tours 20/01/2023

Three tours were conducted on the 20/01/2023 at 10:30 (4 visitors), 13:00 (5 visitors) and at 14:30 (6 visitors). The temperature data for Yonderup Cave on the 20/01/2023 is shown in *Figure 4*. The rise of 0.1°C from the current daily base temperature of 17.5°C, starts at 10:56, approximately 30 minutes after the tour starts, and returns to the base temperature at 11:46. The return time is shown in *Table 1* as 50 minutes.

The base temperature rise of 0.1°C to 17.6°C occurs somewhere after the 10:30 tour but cannot be specifically determined. The 13:00 tour results in a 0.2°C to 17.7°C but it returns to 17.6° after 20 minutes and stays there until the 14:30 tour causes another rise of 0.1°C to 17.7°C. The 14:30 tour rise is completed in twenty minutes and then the temperature is maintained and the new base level of 17.6°C throughout the night with only two fluctuations back to 17.5°C.

The day of the 21/01/2023 maintains the new base line temperature of 17.6°C. The full effects of the tours on the 20/01/2023 cannot be fully specified as the base temperature rose to 17.6°C during the tour times.

Figure 4.

Yonderup Cave Tours 21/01/2023

Three tours were conducted on the 21/01/2023 at 10:30 (6 visitors), 13:00 (11 visitors) and at 14:30 (4 visitors). The temperature data for Yonderup Cave on the 21/01/2023 is shown in *Figure* 5. There are five fluctuations to 17.5°C up until 7:36, but NO rise was registered by the 10:30 tour of 6 people. There are no obvious reasons why the 10:30 tour did not affect the cave temperature. This also occurs on tomorrow's 10:30 tour but then registers for all other days.

The 13:00 tour did register a 0.1°C rise in temperature that took 30 minutes to return to 17.6°C. Then the 14:30 tour registered a 0.1°C rise in temperature that took 20 minutes to return to 17.6°C. The differences in time to return to the 17.6°C temperature, is probably the group size.

Overall no other fluctuations in temperature occurred throughout the day and night.

Figure 5.

Yonderup Cave Tours 22/01/2023

Three tours were conducted on the 22/01/2023 at 10:30 (8 visitors), 13:00 (9 visitors) and at 14:30 (11 visitors). The temperature data for Yonderup Cave on the 22/01/2023 is shown in *Figure* 6. There is only one fluctuation to 17.5°C at 1:46, but NO rise was registered by the 10:30 tour of 8 people. There are no obvious reasons why the 10:30 tour did not affect the cave air temperature.

The 13:00 tour did register a 0.2°C rise in temperature that took 30 minutes to return to 17.6°C. Then the 14:30 tour also registered a 0.2°C rise in temperature that took 60 minutes to return to 17.6°C. The differences in time to return to the 17.6°C temperature, is probably the group size as well as probably spending a longer time at the data logger position.

Figure 6.

Yonderup Cave Tours 23/01/2023

Three tours were conducted on the 23/01/2023 at 10:30 (5 visitors), 13:00 (11 visitors) and at 14:30 (4 visitors). The temperature data for Yonderup Cave on the 23/01/2023 is shown in *Figure 7*. The 0.1°C rise in temperature at 9:06 for 60 minutes does look like a group of visitors but no such group was recorded by DBCA.

The 10:30 tour did register a 0.1°C rise in temperature that took 40 minutes to return to 17.6°C. The 13:00 tour did register a 0.1°C rise in temperature that took 50 minutes to return to 17.6°C. Then the 14:30 tour also registered a 0.1°C rise in temperature that took 50 minutes to return to 17.6°C. The reason that the 13:00 tour and the 14:30 tour both took 50 minutes to return to the 17.6°C temperature is unknown. The fluctuation between the two tours may be a clue to why this occurred but it is unclear.

Figure 7.

Yonderup Cave Tours 24/01/2023

Only two tours were conducted on the 24/01/2023 at 13:00 (6 visitors) and at 14:30 (4 visitors). The temperature data for Yonderup Cave on the 24/01/2023 is shown in *Figure 8.* There are only two fluctuations and they are upwards to 17.7°C at 16:06 and 18:06. This would suggest that the base temperature's next direction is upwards.

The 13:00 tour did register a 0.1°C rise in temperature that took 60 minutes to return to 17.6°C. Then the 14:30 tour also registered a 0.1°C rise in temperature that took 40 minutes to return to 17.6°C. The return times do reflect the number of people in the groups and the length of time may be longer because the base temperature is trying to rise as well.

Note also that the time between the start of the 14:30 tour and when the data logger temperature change has reduced by 10 minutes as well.

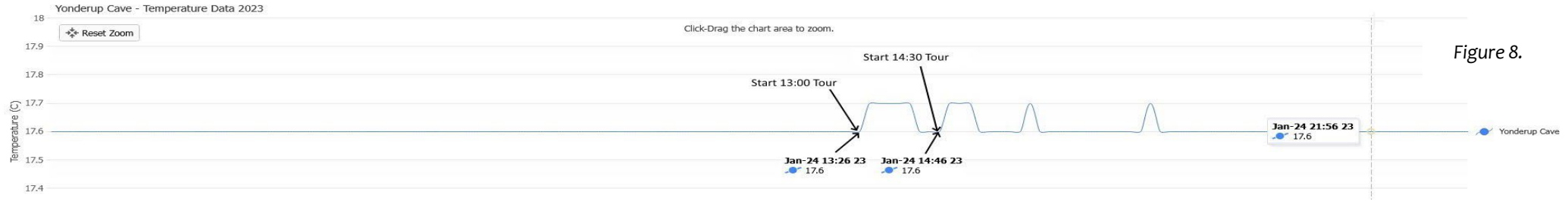


Figure 8.

Yonderup Cave Tours 25/01/2023

Only two tours were conducted on the 25/01/2023 at 9:30 (4 visitors) and at 14:30 (4 visitors). The temperature data for Yonderup Cave on the 25/01/2023 is shown in *Figure 9*. There are only two fluctuations and they are both upwards to 17.7°C at 13:16 and 13:56. This would suggest that the base temperature's next direction is upwards.

The 9:30 tour did register a 0.1°C rise in temperature that took 60 minutes to return to 17.6°C. Then the 14:30 tour also registered a 0.1°C rise in temperature that took 50 minutes to return to 17.6°C. The times for the temperature to return to 17.6°C do vary by 10 minutes, however the sampling time is also ten minutes, so depending when the group arrives and leaves the data logging station will also affect the time for the temperature to return to 17.6°C.

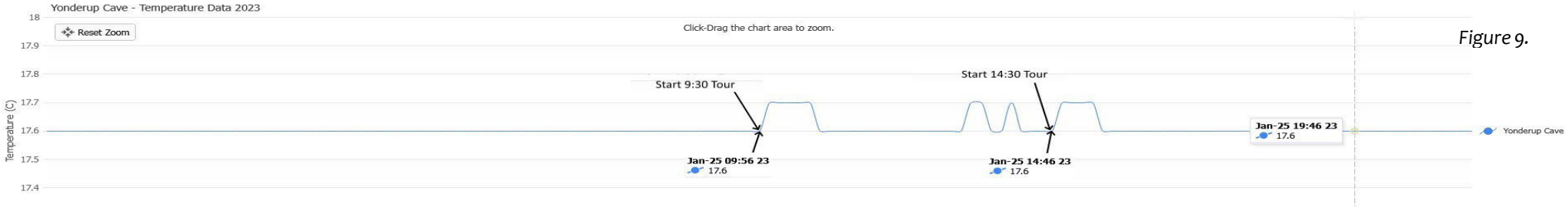


Figure 9.

Yonderup Cave Tours 26/01/2023

Four tours were conducted on the 26/01/2023 at 9:30 (3 visitors), 11:00 (9 visitors), 13:00 (9 visitors), and at 14:30 (10 visitors). The temperature data for Yonderup Cave on the 26/01/2023 is shown in *Figure 10*. There are seven fluctuations and they are all upwards to 17.7°C. This would strongly suggest that the base temperature's next direction is upwards.

The 9:30 tour did register a 0.1°C rise in temperature that took 20 minutes to return to 17.6°C. The 11:00 tour also registered a 0.1°C rise in temperature that took 70 minutes to return to 17.6°C. The 13:00 tour registered a 0.2°C rise in temperature that never returned to 17.6°C. This appears to have occurred because 13:00 tour was still at 17.7°C when the 14:30 tour arrived and created another 0.1°C rise in temperature which only took 30 minutes to 17.7°C but took another 240 minutes (4 hours) to return to 17.6°C. This has occurred because the base temperature is trying to rise to 17.7°C but is still fluctuating between 17.6°C and 17.7°C until the next day when the base temperature does rise to 17.7°C.

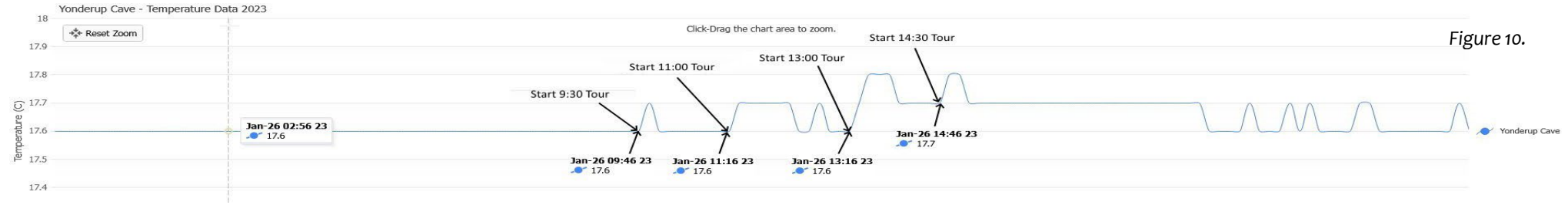


Figure 10.

Yonderup Cave Tours 27/01/2023

Two tours were conducted on the 27/01/2023 at 11:00 (9 visitors) and 13:00 (9 visitors). The temperature data for Yonderup Cave on the 27/01/2023 is shown in *Figure 11.* There are fourteen fluctuations before the 11:00 tour and they are all upwards to 17.7°C. After the 13:00 tour occurs the temperature does not return to 17.6°C but remains at 17.7°C, the new base temperature, and nine fluctuations occur back to 17.6°C but the base temperature remains at 17.7°C and then drops back to 17.6°C during the night/next morning. See the 28/01/2023 Tour data for details.

The 11:00 tour did register a 0.1°C rise in temperature that took 80 minutes to return to 17.6°C. The 13:00 tour also registered a 0.1°C rise in temperature that took 20 minutes to return to 17.7°C and stayed there until a possible 14:30 tour arrived with another 0.1°C rise in temperature that took 20 minutes to return to 17.7°C. The temperature then remained on 17.7°C with fluctuations back to 17.6°C during the night.

The visitor peaks and returns to starting temperatures are clearly affected by the rising base temperature during this day. Somewhere between 13:36 and about 17:00 the base temperature rose to 17.7°C and stayed there.

Figure 11.

Yonderup Cave Tours 28/01/2023

Three tours were conducted on the 28/01/2023 at 11:00 (9 visitors), 13:00 (10 visitors), and 14:30 (7 visitors). The temperature data for Yonderup Cave on the 28/01/2023 is shown in *Figure 12.* A base temperature change appears to have occurred between 11:26 on 27/01/2023 and 00:56 on 28/01/2023. The fluctuations change from dropping down from 17.7°C to 17.6°C to rising from 17.6°C to 17.7°C. After this point the base temperature becomes 17.6°C again.

The 11:00 tour did register a 0.1°C rise in temperature that took 50 minutes to return to 17.6°C. The 13:00 tour registered a 0.2°C rise in temperature that took 80 minutes to return to 17.6°C. The 14:30 tour registered another 0.2°C rise in temperature but the time appears to be too short for the group to reach the data logger (only 6 minutes after the tour started). So it is more likely there was a natural fluctuation of 0.1°C and then the tour arrived at the data logger causing another 0.1°C rise. If so then the temperature change took 90 minutes to return to the base temperature of 17.6°C.

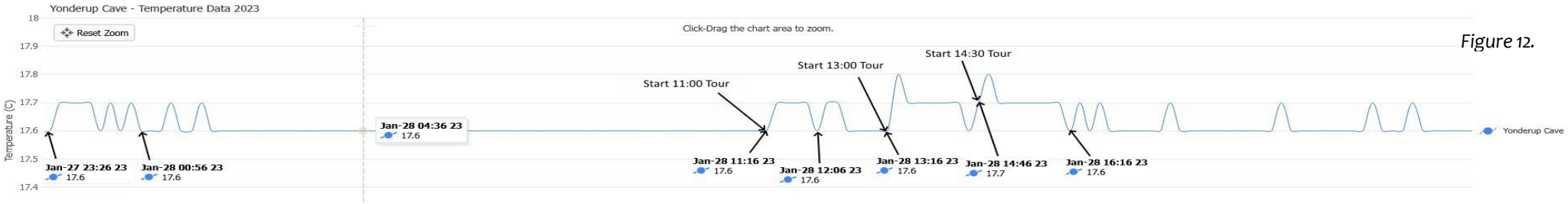


Figure 12.

Yonderup Cave Tours 29/01/2023

Two tours were recorded on the 29/01/2023 at 13:00 (9 visitors), and 14:30 (6 visitors). The temperature data for Yonderup Cave on the 29/01/2023 is shown in *Figure 13.*

The temperature rise from 11:26 to 00:46 looks like it could be a visitor group but there was no 11:00 tour group. Examining the 0.1°C rise at 17:46 (see Figure 13) and lasting for 2 hours and 10 minutes, the morning temperature rise from 11:26 to 00:46 looks very similar. The temperature appears to be trying to rise to 17.7°C.

The 11:00 tour rise is likely to be only 0.2°C from the 13:36 data point with the first 0.1°C rise resulting from the overall base temperature rising. The temperature then returns to the 17.7°C level after 40 minutes. Then the 14:30 tour has another 0.2°C rise which takes 50 minutes to return to the 17.7°C level. There are many 0.1°C fluctuations from 17.7°C to 17.6°C through the night and next morning but the 17.7°C level is maintained into the following day and lasts until the data ends.

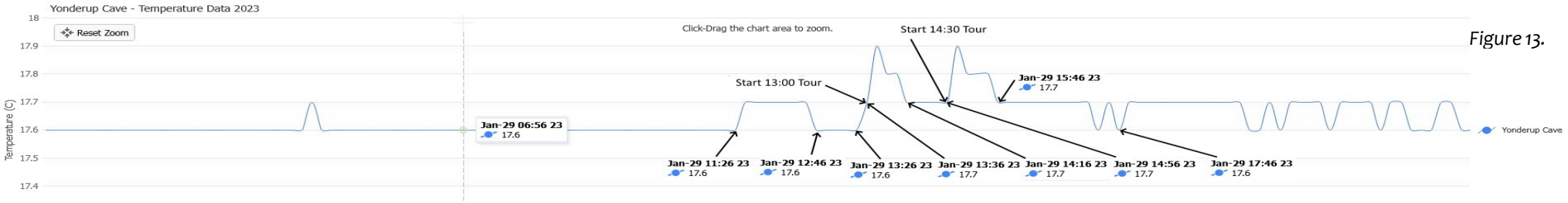


Figure 13.

Yonderup Cave Tours 30/01/2023

Three tours were conducted on the 30/01/2023 at 11:00 (7 visitors), 13:00 (5 visitors), and 14:30 (4 visitors). The temperature data for Yonderup Cave on the 30/01/2023 is shown in *Figure 14.* The many 0.1°C fluctuations from 17.7°C to 17.6°C are shown from the night of the 29/01/2023 into the morning of the 30/01/2023 to shown how the temperature stabilised at 17.7°C just before the tours started.

The 11:00 tour temperature rise was 0.1°C which returned to the 17.7°C level after 50 minutes. The 13:00 tour temperature rise was 0.1°C which returned to the 17.7°C level after 20 minutes. The 14:30 tour had a 0.2°C rise which takes 40 minutes to return to the 17.7°C level. No further fluctuations occur until the data ends at 19:06.

This is one of the clearest examples of tours showing temperature rises from visitor groups but it does not correlate directly with the visitor numbers. If it did then the numbers should be 11:00 (7 visitors), 13:00 (4 visitors), and 14:30 (5 visitors) to produce the results shown in *Figure 14.* Clearly other factors such as time spent in proximity to the data logger and also how close the visitors were to the data logger must be factored into the correlation of results.

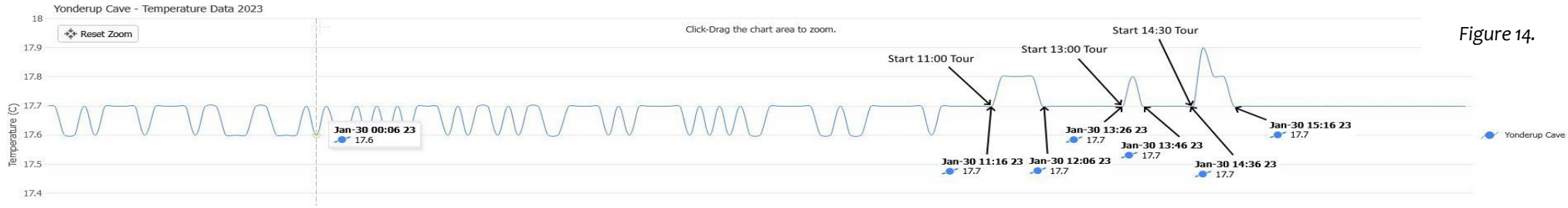


Figure 14.

Overall View of Yonderup Cave Temperature Fluctuations on Tour Dates

Overall correlation of temperature rises with tour dates and times was very high with only two tours showing no temperature rises at all (see Yellow Cells in *Table* 2). There does not appear to be any reason for why these two parties, both 10:30 tours taken one day after the other (21 and 22/01/2023), did not generate any temperature rise. They were parties of 6 and 8 visitors so they would be very likely to register a temperature rise.

Attempts to correlate the size of visiting groups with the time taken for the temperature rises caused by the visitor groups to return to where they started from, prior to the group visit, were not successful. Sometimes smaller groups had longer times for the temperature to return to the starting temperature. Too many factors are in play, such as the length of time spent adjacent to the data logger, proximity to the data logger by the visitors and the rising or falling of temperatures due to overall heating or cooling of the cave system.

The base cave temperature started out at 17.5°C on the 19/01/2023 and rose to 17.6°C on the 20/01/2023. It maintained the 17.6°C base temperature until the 27/01/2023 when it rose to 17.7°C but then overnight reverted to 17.6°C. On the 29/01/2023 it rose to 17.7°C around 13:30 and stayed at that temperature until the end of the data set on the 30/01/2023.

We have also examined the three-day period prior to tours commencing from the 16/01/2023 to 18/01/2023 as a control to show that random events were not occurring at tour times. The data for those three days is shown in *Figure 15*. Note the remainder of 18/01/2023 data was a flat line at 17.5°C.

Figure 15.

The majority of fluctuations in these three days was the temperature dropping from 17.5°C to 17.4°C then fluctuating until it returned to 17.5°C just before the start of 18/01/2023. There were also two obvious events over the three days, one on 16/01/2023 at 11:06 with a 0.1°C rise which took 40 minutes to return to 17.5°C. With no tours on this day this event is a random warming of 0.1°C with no known cause. A second event occurred on 18/01/2023 starting at 14:26 and taking 40 minutes to return to 17.5°C. This event was also a random warming of 0.1°C with no known cause.

All of the morning tours 9:30 or 11:00 have a 0.1°C rise whereas the afternoon tours are more likely to have a 0.2°C rise. This does not appear to depend upon tour group sizes. If the base temperature is changing with a 0.1°C rise then the 0.2°C afternoon rise may only be a 0.1°C rise. These generalisations are only likely to apply to the summer months.

Travel:
Lac Souterrain de Saint-Léonard: Show Cave with the Largest Underground Lake in Europe

Text and images by Garry K. Smith

Member of ACKMA and the Newcastle and Hunter Valley Speleological Society (NHVSS)

Lac Souterrain de Saint-Léonard (French) translates to English as 'Underground Lake of Saint-Léonard' and is located at Saint Léonard in the canton of Valais, Switzerland, part of the Alps Mountain range between Sion and Sierre. The cave entrance is close to the valley floor, nestled in a rich wine growing area surrounded by towering mountains. The tops of some mountains are covered in snow all year round. Stretching from the valley to high on the mountain sides, large rock wall terraces clinging to the steep slopes, are cultivated with grape vines. It is truly breathtaking scenery above ground, but what is hidden below ground is absolutely amazing.

Figure 1: Vineyards cover the terraces at St Léonard, Switzerland(left)

This show cave lays claim to containing the largest underground navigable lake in Europe. It measures 260 metres long x 20 metres wide and has a depth up to 10 metres of crystal-clear water. The lake surface area is approximately 6000 square metres and is between 30 and 70 metres beneath the vineyard. The entire length of the cave is 1400 metres, however a rockpile collapse at the end of the lake, blocks tourist access to the dry passage beyond which is accessible only to speleologists (SWI 2022). The Lac Souterrain website advertises the lake as being 300 metres long, however this appears to be including the bits of dry passage at the entrance and from the end of the lake to the rockpile. Other than the bats which use the cave at the end of autumn and the introduced trout, there is very little in the way of fauna (Wikipedia 2022).

Geology

The cave was formed by groundwater dissolving away Triassic gypsum beds that are emplaced within less pervious Carboniferous strata. The gypsum is preferentially eroded away as it is more soluble than the surrounding rock strata of slate and marble.

While the formation of the rocks in this region was spread over tens of millions of years (beginning of the Mesozoic era through to the Tertiary), the cave is believed to have formed between the late and postglacial period, which is very young on the scale of the earth's history (Futura 2022).

History

The local inhabitants of Saint Léonard and the surrounding area had known of the existence of groundwater for a long time. The current cave entrance was difficult to access as it was completely covered with vegetation, however a few winegrowers did use the pond at the entrance to cool their bottles of "Fendant" (wine made from Valais Chasselas grapes), as the water remained at a constant 11°C (52°F) year-round. The cave beyond was not obvious at the time as the height of the pond exceeded the height of the cave ceiling.

During spring of 1943 the water level lowered to reveal a large cave beyond the known pond.

Local residents contacted the Swiss Speleological Society to inform them of the cave. The then president, Jean-Jacques Pittard, was accompanied by Jacques Della Santa to investigate (Lac Souterrain de St-Leonard 2022, Futura 2022, SWI 2022). Equipped with acetylene headlamps and an inflatable boat, the two men undertook the exploration during Easter 1943. They travelled the full length of the lake and guessed its length to be several hundred metres. Their journey was difficult because in parts the air space was only a few tens of centimetres.

After several hours inside they returned to the entrance and reported on the amazing beauty of the cave. The following year, soldiers specializing in underground reconnaissance carried out the complete topographical survey of the cave (Futura 2022).

At 5.32 pm on 25 January 1946, an earthquake measuring 6.1 on the Richter scale, with its epicentre in the Sion-Ayent region (Bernardi et al. 2005), rocked the area and caused major cracks in the cave side walls and lake bottom. These cracks allowed a greater loss of water to escape from the cave and flow into the water table. As a consequence, the water level dropped more than 15 metres, making the lake more easily navigable (Lac Souterrain de St-Leonard 2022, SWI 2022). Over time the cracks in the lake bottom are gradually being sealed by fine particles of clay and gypsum.

Driven by the motivation of two young Léonardins, the municipality of Saint Léonard granted them a commercial concession in 1949. Visits were organized using a boat made in the village. In the 1950s, the municipality established a new mining concession, and the cave was named "Lac Souterrain de Saint Léonard". Around this time new barges were added and electric lighting installed.

In October 2000 a huge section of rock weighing several tons broke off the cave roof at the embarking point, completely crushing one of the visitor barges (SWI 2022). One could imagine the worst if the fall had taken place during a tour.

This almost led to the indefinite closure of the cave, however aware of the importance of this tourist attraction, the municipality of Saint Leonard voted to provide a credit of two million francs to secure the cave roof. Between 2000 and June 2002, access to the lake was closed while stabilisation work was undertaken. This involved draining the 18 million litres of lake water and refilling it once work was completed (SWI 2022). To stabilize the rock, more than 5000 rock bolts were driven into the ceiling*. A substantial number of the bolts are very large and many metres long. During the closure the boat boarding area was also redesigned.

Today the cave is one of the most visited in Switzerland and attracts more than 100,000 people every year (SWI 2022).

Cave Tours

Visitors are asked to be at the reception area at least 15 minutes before the start of their tour. At the visitor entrance, guests have their QR code scanned from their booking confirmation email and are provided with a printed ticket indicating their designated boat and departure time. While waiting for the tour to start, visitors can enjoy a cake and coffee in the gift shop or browse the rock and mineral samples for sale. There is also a terrace and slippery slide for the children to play on and an education area with information about the formation of the Alps and the lake cave.

At the allotted time the guide leads visitors down the 50-step metal staircase to the platform and jetty at the lake edge. There are several large row boats (barges) tied up and visitors are directed to board their allotted boat, the largest of which can carry up to 40 passengers.

Figure 2: Looking out the entrance of the cave (left)

Figure 3: Start of the tour at Lac Souterrain (right)

One is immediately awestruck by the beauty of the illuminated lake stretching down the sculptured passage. There are perfect mirror image reflections on the motionless lake surface. Fluorescent colours of turquoise and aqua emanate from the water and provide an eerie atmosphere.

Our guide boards last and sets the boat adrift from its mooring. He starts slowly rowing as he begins a well-rehearsed welcome spiel in German, French and English. Tours are available in other languages on request depending on availability of guides.

Some lights point along the cave walls while others are directed into the crystal-clear water. The lighting appears to be a mixture of incandescent (orange yellow) and fluorescent (blue), or possibly a mixture of LEDs warm and cool white, which provide different colour casts. At each light, the crystal-clear deep water glows either brilliant turquoise or aqua colour. There may be some lights with lightly coloured filters over the fittings to enhance the water's natural turquoise colour.

As we slowly glide down the illuminated passage our guide tells us about the geology, history and features of the lake cave. Wall mounted lights illuminate three sunken wooden boats in the deep crystal-clear water. These boats were deliberately sunk in the past to add additional points of interest for visitors (SWI 2022).

Despite our guide delivering his multi-lingual commentary in three languages, I did have lots of trouble understanding his English and, on the whole, comprehended very little of the explanation about the cave. Luckily, I had read the English literature about the cave on the internet before the tour.

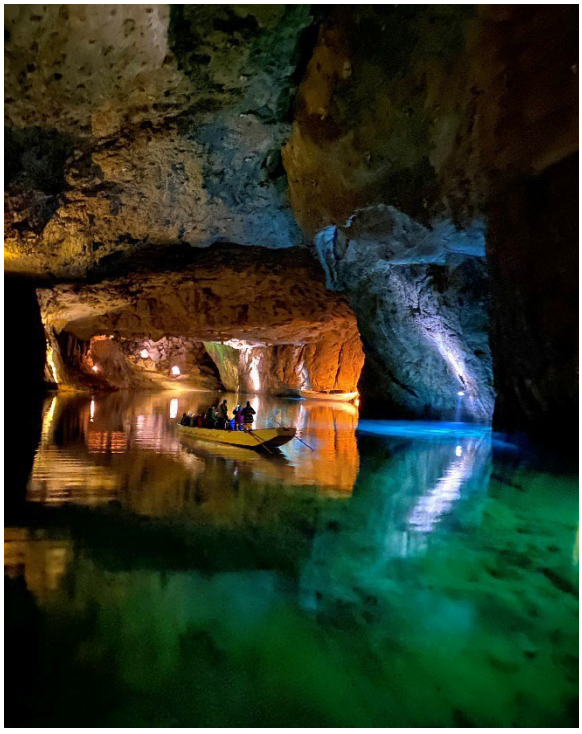


Figure 2: Lac Souterrain de St Léonard (above)

There are quite a few very large fish (trout) swimming well inside the cave. They become quite lively as our boat approaches the back of the cave. It appears the guide had thrown some food in the water as we passed one of the lights. I asked the guide at the end of the tour whether the fish were introduced to the cave. He said, "yes a long time ago", and that they periodically replenish the fish stock as they die, presumably from old age.

Large sections of the cave roof are covered in very large rock bolts in order to stabilise the more brittle gypsum and reduce the risk of collapse. Most tourists would not particularly notice the bolts across the roof as the lighting is installed so as to not highlight them, however I was specifically looking for speleothems and at the geology. The cave appears to be devoid of speleothems throughout its length.

Non-flash photography is allowed, so I needed to change my digital camera onto a very high sensitivity ISO setting to get reasonable images. I also used my phone camera, which did capture quite reasonable images in the low light situation, provided it was held still enough while taking the photo. A bit of a challenge in a slowly moving boat.

Our guide slowly rows our boat containing 40 visitors along the length of the cave while providing a well-rehearsed commentary of things we were passing, such as the three sunken boats, trout, geology and cave history. At the turnaround point at the end of the lake, our guide explains that there are periodically recitals played by musicians on a barge and that the sound of their orchestral performance is enhanced by the acoustic qualities of the cave. Speakers mounted somewhere in the cave provide a short example of the cave's acoustics. This was very tastefully presented, and it certainly highlighted the wonderful acoustic sound that is produced in this subterranean world.

The tour of this amazing and tranquil place via boat, lasts approximately 30 minutes. A short but memorable experience.

Getting to the Cave

Like (almost) everything in Switzerland, the cave can easily be visited using public transport. An easy option is to catch the train to Saint Léonard station, then there is a 15-minute walk (1.1 km) to the cave. Visitors travelling by car can park at the large free parking area less than 100 metres from the cave. From the carpark there is a concrete staircase alongside a paved ramp. There are toilet amenities in the carpark as well as at the reception building. The cave is accessed through the reception building at the back of the gift shop.

Booking Tours

Online booking with a credit card is required via the website www.lac-souterrain.com, as access is not guaranteed without an online booking. When booked online an email is sent to the purchaser, so that the E-ticket barcode can be presented when checking in for the cave tour. If there are available places on tours, tickets can be purchased in person at the ticket counter in the reception building.

Note that the website booking will only allow credit card payments (not direct debit), to secure cave tour tickets. I found there was an issue with using a debit card (that can also be used as a credit card) for payments through this website. The online application form for tickets, requires a security code to be sent to my mobile phone (as listed in my bank's database), and then entered into the website before payment would be accepted. This can be very frustrating if you don't have your Australian mobile phone set up for international roaming while in Switzerland. In my case I had purchased a new SIM card to use while in Europe, however as Switzerland is not in the EU, it didn't work when I crossed the border.

Cave tours are organized daily from mid-March to 1 November, from 10am to 5pm with the exception of July and August when opening time is from 9am to 5.30pm.

Ticket-prices are 12 CHF (Swiss Francs) for adults and 7 CHF for children 5-15 years old. Under 5s are admitted free of charge, however a "Free Ticket" must be booked to save them a seat.

The website suggests that visitors arrive at least 15 minutes earlier than their booked tour to allow time for check-in. Visitors are also advised to bring a jacket as it is between 11 and 12°C in the cave.

Unfortunately, the cave cannot be accessed by wheelchair due to the steps and transfer to boats. Understandably swimming and diving are prohibited.

Special concert tours are periodically scheduled and can be booked in advance. The artistic performances take place on the lake toward the back of the cave. The musicians perform on a boat reserved for them while guests are on other boats only a few meters away. Numbers are limited, so reservations are mandatory and can be made directly online.

Cave administration contact details:
Lac Souterrain de Saint Léonard
Case postale 75
Rue du Lac 21
1958 Saint Léonard, Suisse
Email: admin@lac-souterrain.com
Telephone: +41 027 203 22 66
Website **www.lac-souterrain.com**

Figure 5: Reception building and café (left)

Acknowledgement
Thank you to Katerina Fulton for proof-reading this article.

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*Andy Spate visited the cave in 2005 and was greatly impressed by the scale of the rock bolting and images in the visitor centre showing heavy earthmoving machinery trundling around on the drained lake bottom!

A trip into Inchindown Caverns, Scotland

John Brush, Canberra Speleological Society Inc

The caverns at Inchindown are the largest underground space in Scotland. A chance remark to caving friends during a brief trip to the United Kingdom in October 2022 resulted in Marjorie Coggan and I being invited to participate on a trip into the immense caverns.

The caverns are a series of six huge parallel chambers connected by cross passages at each end. I would like to be able to report they are in limestone and were formed naturally. Unfortunately, I am unable to do so.

The caverns, more commonly known as the Inchindown oil storage tanks, lie deep inside a hill about six kilometres inland from Invergordon in northeast Scotland. This small town on the shores of Cromarty Firth was an important naval base during the First World War. At that time a large above-ground oil storage facility for refuelling naval vessels was considered safe from aerial attack. With the passage of time, that view evolved in line with advances in aircraft design and capability in the years following the First World War. With increasing political tensions in Europe during the 1930s, the British Government decided to construct a more secure storage facility in the Inchindown area.

The underground tanks and associated infrastructure were built between 1938 and 1941. They were connected to the above ground tanks and refuelling depot at Invergordon by two large steel pipes – one for filling the tanks and the other to refuel ships. Both pipes were heated to ensure the heavy furnace oil flowed freely.

We first learned of the tanks from a TV program a couple of months before we travelled to the UK. By chance, the subject came up during discussions with caving friends we stayed with at the beginning of our trip. We were asked "Do you want to go there?" "We know the man who has the key. I will give him a call, if you like". The good news was that the man with the key, Preston White, was planning to take his sister and several friends into the tanks in about a week's time, but no arrangements had yet been settled. We agreed to call him back after we had considered whether we had the time and would be within easy reach of Inchindown.

As it turned out, we were booked into a hotel just 100 miles from Invergordon and there just happened to be a day that suited both Preston's group and us. After we settled on the date, Preston told us what gear we would need. As we had not planned to do any caving, we were a bit lacking in the gear department. All we had was a couple of small but reasonably powerful hand torches that we always carry for possible emergencies. Fortunately, Preston said he could lend us helmets and "Wellies". However, we would need to obtain disposable overalls, gloves and headlights. Easy, we thought. But along the sparsely populated southwest coast of Scotland, hardware shops and supermarkets were few and far between and those that did exist were small and stocked a limited range of goods. To complicate matters, I decided a camera tripod was also essential. Camera shops? Well, Mr Google said there was one in Oban and, as we passed through two days before out trip, we managed to buy one without parting with too much money. The lights we purchased in a supermarket in Oban were barely adequate for a trip to Wee Jasper, let alone for vast oil-stained chambers.

On the day of the trip, we arranged an early breakfast at our hotel and made good time to the designated meeting point at a cafe just a couple of kilometres from the tanks. We then drove up into the forested hills. At the end of the road, all six of us (Preston, Kaye, Hazel, David and us) changed into Tyvek overalls, sorted out gumboots and adjusted helmets (*Figure 1*). I was asked if I could carry a bucket of sand, but the reason for this was not very forthcoming. We then walked a few hundred metres to a concrete tunnel portal nestled into the bush (*Figure 2*).

Figure 1: The party almost ready to depart for the Inchindown tanks (left).

Figure 2: Portal for the smaller access tunnel (right).

At the substantial steel entrance door just inside the portal, 'the man' produced 'the key' and cursed a break-in attempt that required making a few repairs and adjustments. Once inside, Preston gave us a briefing on do's and don'ts. The sand, he now advised, was to cover a line of oily footprints along the tunnel that led off into the darkness in front of us. Preston was obviously not very happy about the footprints in 'his' tunnel.

The access or service tunnel was about 1.5 m wide and 2 m high with vertical walls and an arched roof (*Figure 3*). It connected to one end of each of the oil storage tanks. It was concrete lined for the first couple of hundred metres, near where the first tank was located, but beyond that the tunnel was bare rock as excavated around 80 years ago. In the unlined section there were wooden pit props shoring up the roof in a couple of places where there appeared to be some roof instability (*Figure 4*).

Figure 3: In the concrete-lined section of the small access tunnel (left)

Figure 4: Rock walls and wooden pit props in the more distant parts of the smaller access tunnel (right)

As we walked along the tunnel, Preston gave a running commentary on the history and use of the of the Inchindown facility. He said there was a second and larger access tunnel connecting to the other end of each of the storage tanks, which we would visit later. He said the tanks were used through Second World War and while the surface facility at Invergordon was bombed once, in 1941, the damage sustained was minor. Apparently, a bomb passed right though one tank and set fire to an adjacent one. Fortunately, there was no major explosion and the fire did not spread to other tanks. The location and purpose of the Inchindown facility was a tightly held secret for many years and, as best as local historians can tell, it fell into disuse in the 1960s but was reactivated during the Falklands war in 1982, at which time the storage was filled to capacity. After the Falklands war, the tanks were decommissioned. In 1998, plans to upgrade the facility for NATO use were considered, but later abandoned and the site was decommissioned in 2002. In 2006, the tanks were thoroughly cleaned to make them safe for public entry. Around this time, the facility was sold to a private owner, the Bannerman Company of Tain.

The first public tours were offered in 2009 and were booked out in less than two hours. These early tours were organised by Forestry Commission Scotland, which manages the forest on the slopes above the tanks. Several public tours were also organised by the Royal Commission on Ancient and Historic Monuments. Later, in consultation with the Bannerman family, Preston came to be the tour organiser and holder of the keys (there is one for each access tunnel). Preston conducted regular tours for several years, but these have now ceased and he runs just an occasional trip.

At the first passage junction, we turned into a short side passage. It ended at a concrete wall that had four protruding pipes, each about 50 cm in diameter. The original cover plates on the pipes had been removed so it was possible to peer a couple of metres through the pipe to see the interior of Tank 1. It was, we discovered, also the access point into the tank. All the other tanks had a similar setup. However, to make access into Tank 1 easier, one of the pipes had a concave-shaped bench attached to it (*Figure 5*) and there was a low-profile trolley matching the curvature of the bench that could be pushed into the pipe.

With the aid of a hook on the end of a long steel rod, the trolley was used to push everyone through the pipe to a matching bench inside the tank (*Figure 6*). Most of us had to lie face down on the trolley and fold in our shoulders to fit through.

Figure 5: Preston with the custom-made bench at the access point to Tank 1 (left).

Figure 6: Emerging into Tank 1 on the low-profile trolley (right).

Five of the storage tanks are of identical size; 237 m long, 9 m wide and 14 m high. They are lined with concrete 45cm thick, have a vaulted ceiling and are spaced 15 m apart. They originally had metal racking about half a metre above the floor to support heating pipes, but this has all been dismantled and is stacked along the walls (*Figure 7*). We were told this was to facilitate the cleaning work in 2006.

The floor has a central raised concrete ridge running the length of the tank and there were regularly spaced lateral ridges running out towards the side walls. Despite the cleaning, it is filthy inside the tanks. The walls were streaked with a thick, black, tarry layer. And there was a layer of oily mud on the floor. It seems oil is continuing to seep out of the concrete walls. Surprisingly, there was only a faint smell of oil.

Figure 7: Interior of Tank 1, one of five identical tanks, each 237m long

To reduce the amount of oil we picked up, Preston suggested we refrained from touching the walls and other surfaces. He insisted that as we wandered around, we did so only on the raised ridges, which were still relatively clean. It now became apparent why Preston was so sensitive about the oily footprints along the access passage. Had there been unauthorised access, or was it a careless visitor, we wondered?

Preston switched on a couple of portable floodlights and together with our headlights, we walked to the far end of the tank to look at the oil filling and draining apparatus. When oil was removed from the tanks, it was skimmed off near the surface, where it was warmest and therefore most fluid. This was achieved by means of a swivel joint in the pipe where it entered the tank at floor level and there was a manually operated pulley system, operated from outside the tank, to raise or lower the end of the pipe.

Preston came well equipped to demonstrate the amazing acoustics in the tank. He produced several items capable of making loud noises and we tried to count how long the echoes lasted. The general consensus was at least several seconds. This was far short of the (world) record in 2014 when an acoustics engineer armed with a gun and sophisticated recording equipment claimed the sound of a shot reverberated around the cavern for 112 seconds.

Before we left the tank, we tried taking a few chamber shots, of the photographic type, and while the new tripod worked well, our rudimentary lighting made the task difficult.

Before we left the smaller access tunnel, we walked to the end to visit the sixth and innermost tank. This tank is only two-thirds of the length of the others, but it has the same height and width. We did not go in but peered in through the uncapped service pipes. We could see that the metal racks and heating pipes were still fully in place. It was suggested to us that this indicates the tank was never used and therefore did not need to be cleaned. However, photos available on-line clear show an oily tide mark around the vaulted ceiling.

After we returned to the surface, we walked to the portal of the second and larger access tunnel (*Figure 8*). Here there were also signs of forced entry and in fact, some of Preston's hidden security features had been damaged, most likely by a thin cutting disc attached to a portable angle grinder. We spent some time making rudimentary repairs and discussing how to make the gate more resistant to any future angle grinder attacks.

Figure 8: Portal for the main access tunnel (below)

Figure 9: Typical view along the main access tunnel (right)

The main access tunnel (*Figure 9*) is about 2.5 m wide and has large oil pipes embedded in the concrete floor. All the valves to control the flow of oil were operated manually, as was the winching arrangement for raising and lowering the fuel supply pipes inside the tanks, as noted above (*Figure 10*).

Figure 10: Hand operated valve and winching equipment for controlling oil flow from the tank (left)

Back on the surface, we had a quick look at the electrical supply substation and switching building for the facility. The camouflage pattern on the exterior was remarkably intact. However, the interior had been severely vandalised. All of the switching equipment was smashed and the wiring had been torn out, presumably to salvage the copper. According to Preston, the interior and its contents were almost intact until a few years ago.

While it could be argued our visit to the oil tanks was only tenuously connected to caves and karst, it became apparent through the day that many of the management issues faced by Preston are very similar to those regularly encountered by cave managers: unauthorised access, forced entry, angle grinder attack, interior damage, vandalism, graffiti and mud tracking.

Acknowledgments: We are very grateful to Preston and his sister and their friends for inviting us to participate on their trip. We also thank the Bannerman family of Tain for granting access to their underground property. It was a memorable and highly enjoyable trip.

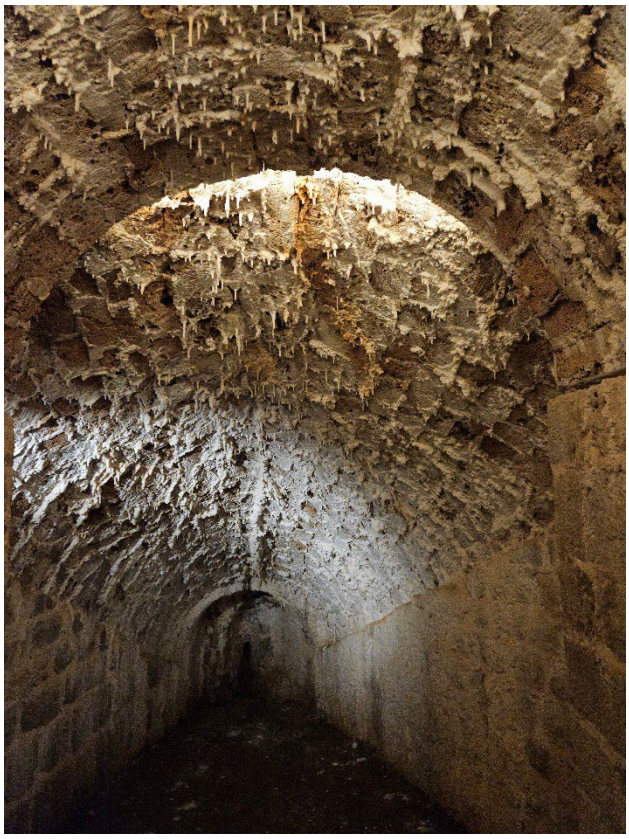
Dubrovnik Embrasures
Tim Moore

The north-western walls of Dubrovnik, a fortified mediaeval city at the southern extent of Croatia, were constructed during the first half of the 14th century. This element of the walls is some 10 or more metres thick with at least an upper and lower gallery running within the walls underneath the ramparts (*Figure 1.)*

Inside the lower of these two galleries, a gallery whose floor is of the bedrock upon which the walls are founded, are located a number of defensive embrasures.

The wall is constructed entirely of limestone blocks. The lower gallery in this section of the wall forms part of a museum dedicated to the preservation and display of the earliest weapon manufacturing foundry which had been constructed and operated in portion of this gallery.

Figure 1: Fortified walls of Dubrovnik, Croatia (right)



The curiosity of the various embrasures is that they have, by virtue of the downward trickling of rainwater (through joints in the limestone blocks) come to resemble small caves because of the hundreds (if not thousands) of straws that have grown on the roof of each of these embrasures. This can clearly be seen in the image in *Figure 2*, one taken from the gallery into one of these defensive embrasures.

Figure 2: Speleothems on the roof of one of the embrasures (left)

Incidentally, an examination of the length of the longest of these formations (approximately 6 or 7cm being my estimate) confirms the general proposition regularly advanced by cave guides as a truism that such formations grow at a rate of approximately 1 cm per century – the 6 or 7 cm length confirming the time between the construction of the wall in the mid-14th century and my inspection of these embrasures some nearly 700 years later in May of this year).

The correctness of this general assertion is the subject of commentary by Andy Spate elsewhere in this edition. However, in light of the age of the walls here discussed, the formations shown cannot be older than seven centuries or so!

Note: see the ANDYSEZ article on page 30 for further discussion on speleothem dating and its difficulties

Caves and geotourism in Australia

Andy Spate

Member, GSA Tasmanian Geotourism Sub Committee

Member, Working Group 6 of the Australian Geoscience Council's National Geotourism Strategy

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At the Inaugural Global Geotourism Conference *Discover the Earth beneath our Feet* held in Western Australia in 2008, I and others presented a paper titled *Show Caves: Australia's oldest form of geotourism?* This prompted geotourism enthusiast Angus M Robinson to suggested that I prepare a contribution for TAG, which to my shame I did not complete – until now (2022).

Caves are places that people from all walks of life will visit at least once in their lives, and an important heritage to pass on to future generations ... as well as being wonderful at places to inspire interest in one of the spectacular processes in geology. Plus, palaeontology, archaeology, significant cave-adapted faunas, and stunning underground aesthetics.

Although Aboriginal Australians have used caves for millennia to gather resources, for access to water, for funerary practices, art galleries and as living sites we know comparatively little about these activities. Although-in some parts of Australia, caves may have been thought to contain evil spirits or to be otherwise unavailable for use, but we know that on the Nullarbor and in Mount Gambier region, for example, caves were penetrated well into the dark zone by First Peoples. In Nullarbor caves these visits extended many hundreds of meters in total darkness for access to flint for tool making and probably for water. Many art sites are known in these areas. Although caves appear to have been regarded as 'taboo' sites in south-eastern Australia, there is increasing anecdotal evidence that calcite crystals from deep within caves were used for medicinal and ceremonial purposes.

The Nullarbor caves document Australia's drift north into aridity. In wetter times calcite was deposited, followed by gypsum and then halite. Here in Witch's Cave, we see a dark calcite column being wedged apart by today's salt.

Image courtesy of Kirsty Dixon.

European use of Australian caves seems to have started with the rudimentary development for tourist access in Limekilns Cave, near Bathurst, in 1822. By the 1860s and 1870s formal cave tourism was well underway in most States. Australia began to export innovative show cave management practices to the world by the 1890s although some of those practices are regarded with horror by modern managers!

There are currently 26 show cave operations in all states - except the Australian Capital Territory - where Cotter Cave was operated as a small-scale operation in the 1930-50s - my first cave! The location of these 26 is shown on the map in *Figure 2.*

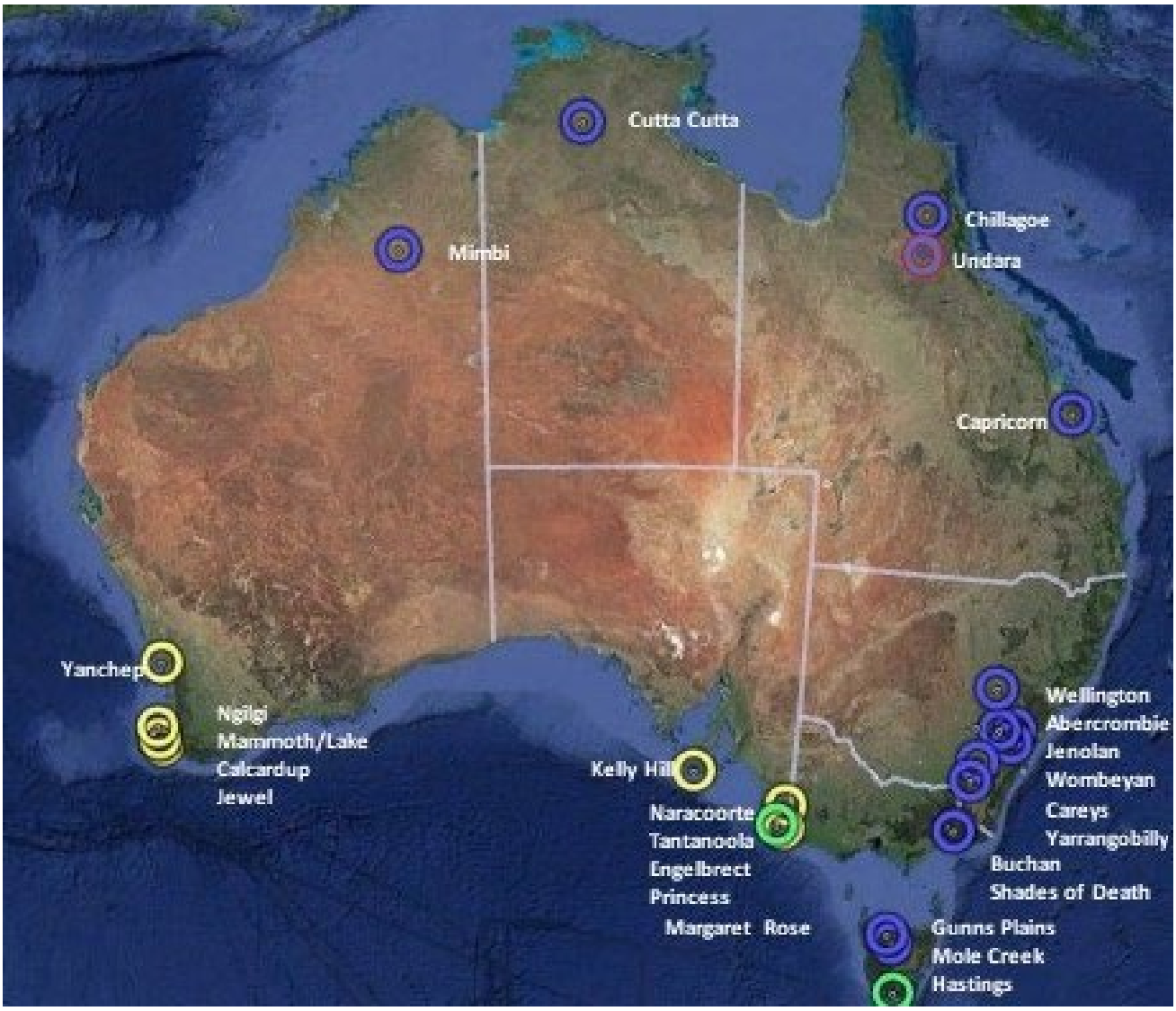


Figure 2: Show cave distribution in Australia. Blue = Palaeozoic age limestone; Yellow = Cenozoic age limestones; Green = dolomite. Hastings Caves = Cambrian age; Tantanoola Cave = Pleistocene age; Undara = Miocene age lava.

The actual number of caves shown on tours conducted nationally is unknown but is around 70 with the reason for this uncertainty is that more than one tour may be operated in the same cave, as takes place at Jenolan and in Careys Cave at Wee Jasper, for example.

Most of the show caves are in limestone (in which Australia has some significant karst features on a world scale - especially in the very young (geologically) syngenetic karst of the Quaternary aeolian limestones of southern Australia). Two are in dolomite and there are several lava tube caves at Undara in Far North Queensland.

What has this to do with geotourism? Somewhere toward half a million people pay to visit Australian caves each year - some of the numbers are 'commercial in confidence' so accurate visitor numbers are unavailable. For many, this visit will be the first exposure they will have to Australia's (or any) geoheritage - and where there will be at least some interpretation. The standards of cave interpretation vary widely in terms of quality and content generally. Caves, and cave tour operations are, unfortunately, great generators and perpetuators of myths - and the 'Chinese Whisper' phenomenon is alive and well. Be that as it may there is almost always an attempt to impart some geological and geomorphological information as part of cave tours.

In defining its place in geotourism, the natural heritage of Australian show caves is a celebration of their geodiversity, biodiversity as well as their cultural heritage extending over 45,000 years through their significance to Australian Aborigines, and post 1788, for their European occupiers and developers.

With the advent of the Australasian Cave and Karst Management Association (ACKMA) in 1987 the standards of show cave interpretation lifted dramatically but sadly, there has been a decline in many areas over recent years despite ongoing efforts by ACKMA. its individual members and some of the show cave operations. Not only were these efforts aimed at increasing the quality of material presented but innovative ideas have been introduced, such as the need for some guides to have voice training as an OH&S issue.

ACKMA has a significant international reputation in show cave development, management and interpretation with individual members or the organisation itself undertaking consultancies in show cave lighting, show cave infrastructure, interpretation, development and evaluation of World Heritage proposals related to karst, and so on. These have been mainly in Asia and the Pacific. The organisation has, or has had, members in Australia, New Zealand, South Africa, Malaysia, South Korea, Canada, the USA, Great Britain, Bermuda, Ireland, France, Italy, Slovenia, Slovakia, Oman, China and Japan. ACKMA was the main proponent and supplier of information to Geoscience Australia's 2000 publication *Discovering Australia's Caves*. It also publishes a quarterly journal and has an effective website www.ackma.org.

Geologists taking cave tours may undoubtedly on occasions have been less than happy at the geological information being imparted. Some discussion after the tour will usually be appreciated by tour conductors - debate on the tour will not be! It must be remembered that guides and their management usually have had little formal exposure to geology. Many show cave operators, ACKMA and individual guides would welcome input from visiting geologists.

Specialists need to understand how difficult cave guiding and interpretation can be. As an example, on Boxing Day some years ago I was on a guided tour at Jenolan. The Christmas-New Year and Easter periods are the busiest for show caves and are regarded with trepidation by those rostered on! My guide that day was a mature male, but new to guiding. His party size was 27 with 11 nationalities! Some with no English. This would be a challenge to anyone, and he coped as well as could be expected - or somewhat better. Jenolan with its large numbers of overseas clients obviously has real challenges as does Margaret River for the same reasons. But the smaller operators often lack the resources (or inclination) to educate their guides - and here there is an opportunity for the GSA to assist whilst promoting geological understanding as the basis of natural and cultural heritage interpretation.

Angus Robinson and David Gillieson provided welcome input to this article, and I thank them warmly for their contributions.

ANDYSEZ 64 - Speleothem ages yet again!
Andy Spate

She-who-must-be-obeyed has asked me to comment on this link to show caves in California.

https://www.atlasobscura.com/articles/how-to-decode-a-cave

Overall, it is a nice article. But three things come to mind:

- We don't find sodium carbonate in caves unless we are baking cakes.
- There isn't necessarily a tipping point between caves being eroded and having speleothems - plenty of stream caves busily eroding away have speleothems merrily growing at the same time.
- The dangers of talking about speleothem growth rates.

This last is a constant bugbear of mine. The decoding article says as a rule of thumb it takes "a cubic inch in a hundred years". Why here am I thinking that we should say a cubic inch a thousand years – much slower growth rates in Australia – laughs hollowly. Or is it a cubic centimetre a thousand years? Or as Tim Moore points out above a centimetre every 100 years. Tim's example at least has a 'concrete' starting point – 700 years ago.

Why do I keep worrying us all about this? A few years ago, I was in a show cave where the guide was asked about stalactite ages – the guide pointed at various stals and provided ages that were older than the bedrock in which they were found! I recognise that the age of things is one of the most frequently asked questions but so often speleothem ages are quoted based on little or no hard data. And no understanding of how and why ages are problematic. In last year's visit to the UK, I was exposed to cave guides talking about the ages of stalactites and stalagmites and shuddered about the 'information' supplied.

I talked about speleothem ages in ANDYSEZ 27 (https://ackma.org/Proceedings/andysez/as27.html) and ANDYSEZ 28 (https://ackma.org/Proceedings/andysez/as28.html).

I asked Andy Baker to comment on these – based on a recent paper of Andy and his co-workers which described dating stalagmites in annual layers. Andy's comments were:

I suggest that dating methods have improved, including the identification of annual laminae which means we can count at an annual scale. And that improved dating evidence suggests growth rates are very constant over time, which makes sense if you consider it hard to change the characteristics of a karst water store feeding the drip that persists for thousands of years.

I had a quick look at your ANDYSEZs and I suggest the growth rate 'variability' might be due to the very large uncertainty in the U-Th ages. You write that you ignore the error terms. What happens if you include the age uncertainties in your estimate of growth rate? And include that uncertainty in the growth rate estimates? I suspect you can get a wide range of possible growth rates. For example, you have 38800+/-2500 and 35000+/-2200 The uncertainty or error on a radiometric age was historically recorded as one standard deviation. What this means is that there is only 66% chance that the actual age falls within the plus and minus error range. If you double the plus and minus error range, then the actual age has a 95% chance of being within the plus and minus error bounds. Then, if you look at both of the examples in the ANDYSEZs, the age of the older (lower) analysis could be younger than that of the younger (upper) analysis, which is impossible. In other words, the dates are so imprecise that you can't use them to measure growth rates.

Andy Baker mentions above that "*that improved dating evidence suggests growth rates are very constant over time*". But look again at ANDYSEZ 28 and the image on the right. The periods of growth are clearly not constant over time – there are two, if not more, growth periods in this stalagmite from Castle Cave at Yarrangobilly (incorrectly labelled). There was a major hiatus between 35,000 years BP and 4,000 BP. What happened then? The last 'Ice Age'. But why the pause between those two periods?

What all this points out at why one should avoid that very commonly asked question – how old are these things? Safer to say that it is highly variable due to differences in regional environmental conditions!!!

Conference Sneak Peek

While most people are still making their way home and undergoing recovery from what we hear was a fabulous conference in Takaka, I think it unreasonable to expect conference reports in time for this journal – but I hope to have some more detailed impressions and descriptions of the conference and associated activities for the September journal!

In the meantime, to whet your appetite, I have received the following photos and comments:

The field trip to the disused Te Anaroa show cave on private property owned by Aaron McLellan in the Aorere Valley, midway between Takaka and Collingwood (photos used with permission of owner)

Figure 1: 10,000-year-old penguin bones (left), photo Arthur Clarke

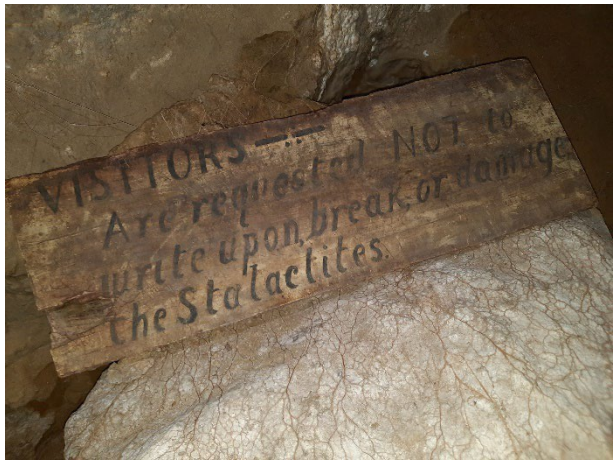


Figure 2: Old signage in Te Anaroa Cave (above), photo Arthur Clarke

Figure 3: Arthur Clarke and Dave Merritt in Te Anaroa Cave (below right), photo Neil Collinson

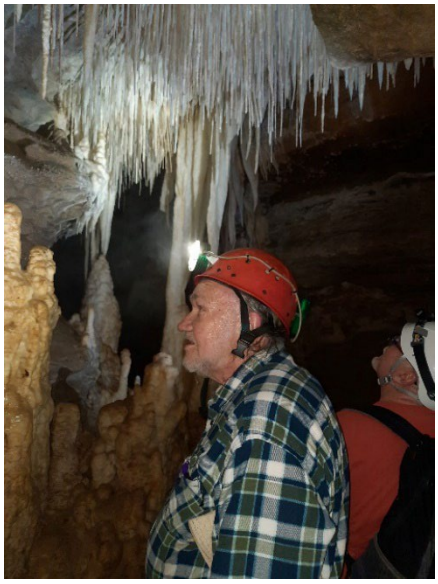
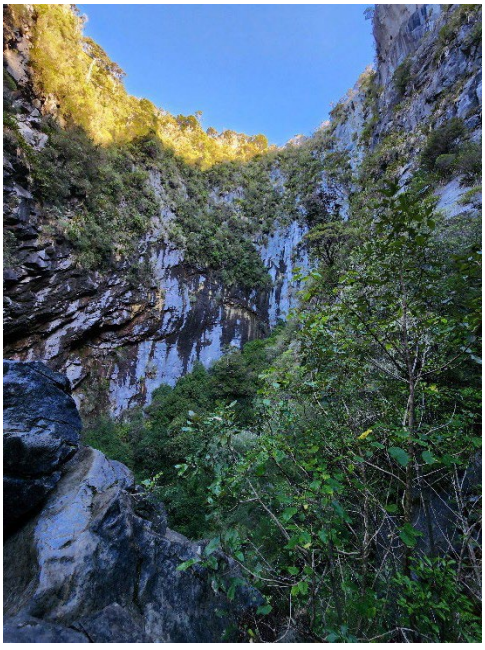


Figure 4: Harwoods Hole (below left), photo John Brush



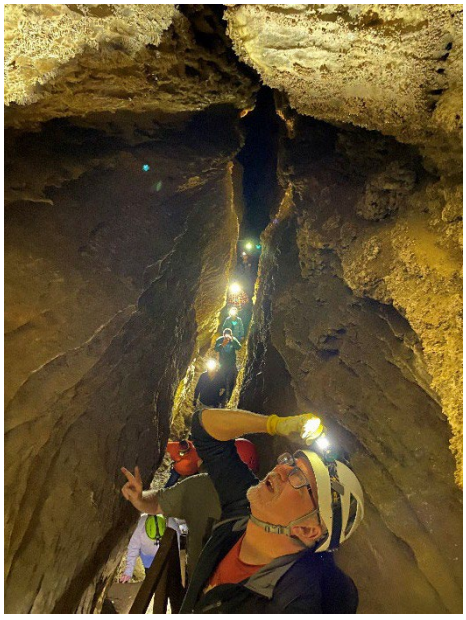


Figure 5: Conference delegates in Te Anaroa Cave (above middle), photo Neil Collinson

The best response I have seen so far comes from John Ash and so perfectly describes the feeling I am getting from everyone, that I have asked him for permission to reproduce it here.

“Kia ora all

Struggled home from the south driving through spitting rain and a rather long and tedious trip - but with lots of time to reflect on the wonderful job that you all did with regards to organising the Takaka ACKMA Conference. Andy and Elery would have been very proud to attend such a gathering - in a far-flung corner of South Island karst, and enjoyed the superb scenery, wonderful texture and taste of the caves, karst and food and to have mixed with the 40 or so delegates.

It was a privilege to participate in the Mihi Whakatau led by the Ngati Tama and become immersed in the 10-year battle to acknowledge the region's taonga - the Waikoropupu Springs and their ancient aquifer. ACKMA has adopted a position of acknowledging First Nation People and this was a fine example of genuine respect between people and the imperative to embrace kaitiakitanga - the guardianship of our natural resources.

It was so rewarding to find characters, who served us our cafe lunches or took us on high tech LIDAR flights of fancy over the local karst, also starred in videos like "The Exploration of Ironstone" - thereby enhancing the connections between community and cavers. To appreciate the longer distance links when cavers associated with the initiative to purchase and preserve land above the 40 km Greenlink-Middle Earth system proudly stood on site and acknowledged the $10,000 contribution that ACKMA had made to their cause.

It might have felt like "a fine balancing act" for you at times, but everyone appreciated the relaxed and fluid nature of both the presentations and the field excursions, and your warm and inclusive "marshalling". All delegates would have noted that the organisation was in a sense "remote" as Takaka the venue is situated almost at the halfway point between Te Anau (Neil) and Waitomo (Pete, Libby, Kieran) - almost 2000 km apart!! WELL DONE!

Whoever "massaged" the unpredictable weather projections did a superb job, and more importantly, the weaving of the organisational 'threads' throughout the community made everyone feel like, and leave feeling like, "locals".

If I remember rightly, David Gillieson’s “ACKMA Strategic Plan- Where to from here?" included "belonging to something that you felt was worthwhile".

This conference achieved that goal.

Ngā mihi nui

John A”

Geoff Melbourne’s Retirement

An ACKMA friend was visiting Jenolan Caves and just happened to be on Geoff’s last tour before retirement.

Well done Geoff – we hope you really enjoy yourself and thanks for all the dedication and energy you put into your many years of guiding!

Photos from Kevin Kiernan

Links to the Wider World

This section aims to provide links to articles and items related to caves and karst that may lie outside the normal ACKMA sphere of influence but may still be of interest. They are intended to spark your interest and maybe prompt you into doing more research - they are not necessarily meant to be definitive sources of information. All links are functional at the time of publishing but may not open if viewing at a later date.

Moeraki Boulders, New Zealand
Taken from the Geology Science website.

https://geologyscience.com/gallery/geological-wonders/moeraki-boulders-new-zealand

A very interesting article on the Moeraki Boulders, covering their formation, composition, age, appearance and size, cultural significance and legends and FAQs.

The Moeraki Boulders have recently been listed as New Zealand's first UNESCO Global Geopark!

Congratulations NZ!

Scientists Identify the Origins of Sulfuric Acid Responsible for Creating Stunning and Distinctive Cave Systems
Taken from the SciTech Daily website.

By Geological Society of America, February 13, 2023

https://scitechdaily.com/scientists-identify-the-origins-of-sulfuric-acid-responsible-for-creating-stunning-and-distinctive-cave-systems/

Dimitri Laurent explores a typical gallery in the Nébélé Cave, that was formed by sulfuric acid speleogenesis. You can see a deep notch that indicates the former presence of a river, and sodium sulfate on the left that is produced from weathering by sulfuric acid. Credit: Christophe Durlet

Reference: "Unravelling biotic versus abiotic processes in the development of large sulfuric-acid karsts " by D. Laurent, G. Barré, C. Durlet, P. Cartigny, C. Carpentier, G. Paris, P. Collon, J. Pironon and E.C. Gaucher, 20 January 2023, *Geology*.
DOI: 10.1130/G50658.1

THE INTERNATIONAL SHOW CAVES ASSOCIATION (ISCA) CELEBRATES THE INTERNATIONAL DAY OF CAVES AND THE SUBTERRANEAN WORLD 2023

INTERNATIONAL SHOW CAVES ASSOCIATION

Dear ISCA family,

On June 6, the International Show Caves Association will celebrate the International Day of Caves and the Subterranean World. Follow the link below to download the full press release both in English and Spanish:

- ISCA Press Release on June 6, 2023

One more year, we would love you to join us and share your events with the rest of the caving community by using the hashtag **#CaveDay** on social networks. Please, send us your materials so that we can share and publish them too.

Sincerely,

INTERNATIONAL SHOW CAVES ASSOCIATION

Juanjo Tíscar Moya

Secretary

International Show Caves Association

+34 660 244 650

secretary@i-s-c-a.org

https://www.i-s-c-a.org/

Spain

An excerpt from the press release is reproduced below:

On June 6, the International Show Caves Association (ISCA) will be celebrating the International Day of Caves and the Subterranean World, a date marked in the calendar of show caves, mines, organisations and show cave managers from all over the world.

During the next few days, especially at the weekend -June 10 and 11-, a series of varied and different events will take place at the different show caves participating. These include special offers for families and groups of friends, concerts, photography contests and other activities addressed to the general public.

In a joined effort to reach the official declaration of June 6 by UNESCO, the International Show Caves Association will be focusing on the power of social media and the technological world in order to show the global impact, both regarding tourism and job opportunities, which show caves provide.

For this reason, ISCA encourages all entities to collaborate in such a special day by sharing their actions with the hashtag **#CaveDay** on any of the most famous social networks at their disposal, as well as other media-related possibilities. The ISCA official Facebook page will be sharing different publications in order to reach a wider audience, and all the information will be collected in order to be published in future releases, including the ISCA Newsletter which is published every other month and whose next issue is expected to be available on July 1 on the association's main page.

The President of the International Show Caves Association, Friedrich Oedl, reflected upon "the importance of show caves not only nationally and internationally speaking, but also in terms of regional economies," and insisted on "the necessity of taking this celebration to the rest of the world so that they learn about the entertaining and learning possibilities of caves and the subterranean world."

Life Without Light: Creatures in the Dark with Sarah McAnulty
An Atlas Obscura online 4-part course

This may be of interest if you are looking for something extra to do with your time, or maybe help educate your children / family?

https://www.atlasobscura.com/experiences/nocturnal-animals-course

Some of the most magnificent creatures on the planet have survived and thrived in the dark for millions of years, and in this course, Dr. Sarah McAnulty will introduce us to some of these characters rarely seen in the light of day. We'll cover nocturnal species, looking at the senses they rely on and extraordinary ways they've adapted to moving and communicating through darkness.

This course includes four total sessions, each lasting for 1.5 hours on four Tuesdays beginning June 20, skipping July 4. (8:00pm – 9:30pm ET US which is 10:00am – 11:30am EST in eastern Australia)

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6 Ways to See Texas Below the Surface
Taken from Atlas Obscura itineraries

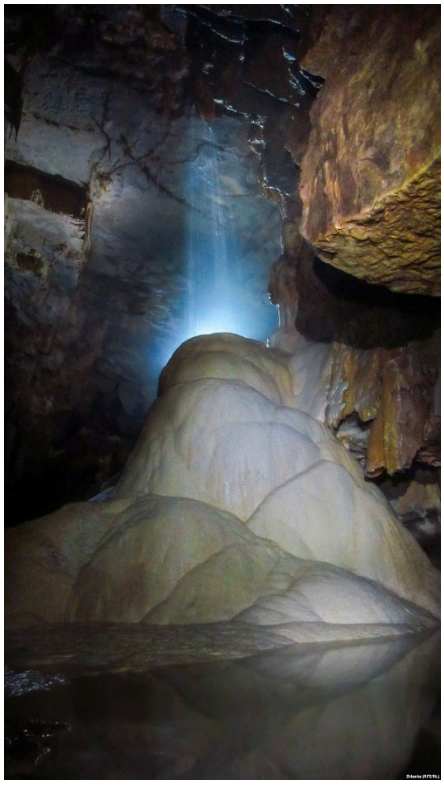
https://www.atlasobscura.com/itineraries/6-ways-to-see-texas-below-the-surface

This is a great article giving some interesting ideas for underground exploration in Texas – how to explore the state's caves and caverns, and fascinating geology.

Image: Caverns of Sonora. These crystal-like speleothems are formed by thousands of years of limestone drips. Woody Hibbard on Flickr

How Five Bulgarian Spelunkers Made the Cave 'Discovery of The Year'

Taken from the RFERL website, May 16 2023



https://www.rferl.org/a/bulgaria-spelunking-zidanka-cave-discovery

Cave explorers Simeon Nenkov, Georgi Nenchev, Stanislav Asenov, Konstantin Stoichkov, and Slaveya Kostadinova discovered a beautiful hall within the cave complex of the Iskar Gorge of Stara Planina near Lakatnik, Bulgaria.

The hall was white and huge, measuring 72 meters long, 17 meters wide, and 15 meters high. Kostadinova described it as "surreal." Unlike the other caves in the area, the Zidanka hall abounds with all kinds of secondary cave formations, such as stalactites, stalagmites, draperies, and crystals.

After its discovery, the problem now is keeping the site from becoming damaged. By entering the hall, one must walk through the deep, sticky mud, followed by fragile snow-white formations that can easily become damaged or dirty.

Image: A huge stalagmite formed by the waterfall in Zidanka, RFERL

Nullarbor rocks reveal Australia's transformation from lush to dust

By Curtin University

Taken from the Phys.Org website.

https://phys.org/news/2023-04-nullarbor-reveal-australia-lush.html

Curtin researchers have discovered how long ago the Australian Nullarbor plain dried out, with a new approach shedding light on how ancient climate change altered some of the driest regions of our planet.

Image: Drone image of the Bunda Cliffs, where the Nullarbor Plain meets the Great Australian Bight. Layering in the cliffs represent different limestone units. Credit: Dr Matej Lipar.

More information: Maximilian Dröllner et al, Directly Dating Plio-Pleistocene Climate Change in the Terrestrial Record, *Geophysical Research Letters* (2023). DOI: 10.1029/2023GL102928

Cave diving detectives search for fossils in hidden depths to shed light on giant life forms
Taken from the ABC website, 10 April 2023

Daniel Keane and Stacey Pestrin

https://www.abc.net.au/news/2023-04-10/cave-diving-detectives-search-for-fossils-in-hidden-depths

Specialist divers are helping researchers from a Queensland university explore underwater caves in Mount Gambier. Despite the sunken setting, these creatures weren't forms of marine life — they were giant marsupials, and they became extinct tens of thousands of years ago.

Image: Julien Louys is a palaeontologist and an experienced scuba diver. (Supplied: Steve Trewavas)

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10 Places to Experience Nevada's Extraordinary Geological Gems
Taken from the Atlas Obscura website

https://www.atlasobscura.com/lists/10-places-to-experience-nevada-s-extraordinary-geological-gems

Hundreds of millions of years ago the land that's now Nevada was almost entirely underwater. While the seas have long since receded, what they created and left in their wake is a place where geologic wonders and natural marvels abound.

Diana's Punch Bowl is a spectacular hot pool in a large travertine basin in the middle of Monitor Valley, northern Nye County, Nevada.

image: Diana's Punch Bowl, photo by slgwv (Atlas Obscura user)

Fly Geyser, Gerlach, Nevada - A collision of human error and natural geothermal pressure created this rainbow-colored geologic wonder.

As well as Lehman Caves!

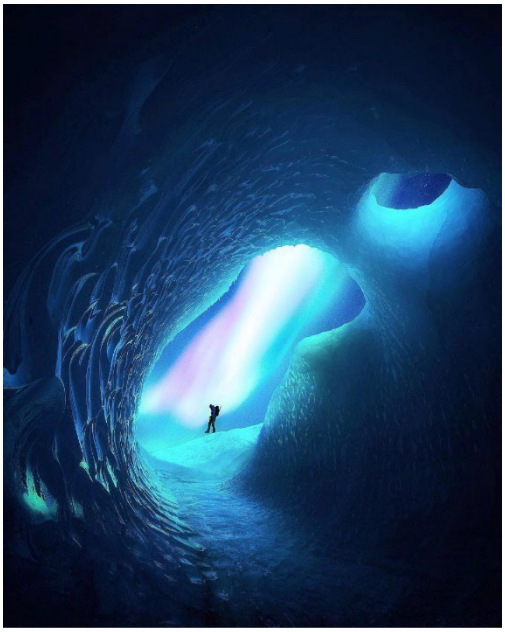
Image: Fly Geyser, photo by Ken Lund / cc BY-SA 2.0

The Otherworldly Ice Caves of Iceland
Photos by Ryan Newburn, Ice Pic Journeys

https://icepicjourneys.is/

For those interested in a slightly more adventurous travel option with the bonus of fabulous photography…

.. and because it is just a stunningly beautiful photo!



The majestic beauty of Va Cave, Vietnam's Hidden Gem
By Bich Phuong, 12 April 2023, Photos by Ngo Tran Hai An

Taken from the VNExpress website travel guide.

https://ampe.vnexpress.net/photo/places/the-majestic-beauty-of-va-cave-vietnams-hidden-gem

The Va Cave system features intricate and one-of-a-kind stalagmites in the stunning Phong Nha-Ke Bang National Park in Quang Binh Province. Located near the exit of Son Doong Cave, and connected to Nuoc Nut Cave, Va Cave stretches 1.7 kilometres along the Ho Chi Minh Highway.

Image: Entrance to Va Cave at the end of March (below left).

Image: Va Cave features a remarkable system of stalagmites with about 1,000 blocks of uniform size (above right)

JIM WERKER
CELEBRATION OF LIFE

We are sad to see that Jim Werker is no longer with us. Jim and Val were honoured with awards for coordinating and editing the internationally recognized book titled *Cave Conservation and Restoration* (NSS 2006, https://learnmore.caves.org/index.php/educational-materials/), which raised the bar for current best practices in sustainable cave stewardship and minimum-impact caving standards. This 600-page book is a remarkable work that anyone interested in the topic should have.

Jim's celebration looks to be a remarkable occasion for a remarkable man.

After an intense year of in-patient treatment and out-patient rehab for a stroke and seizures, Jim Werker contracted COVID and died on April 13, 2023. Join us in celebrating a life and spirit measured in miracles.

SUNDAY JUNE 11, 2023
Memorial Celebration at 10:00AM
Hillsboro Union Church

Hillsboro Cemetery

Red/Green Chilli Buffet & Jim-Memories
Hillsboro Community Centre

Honour Jim's love of New Mexico Chilli with your favourite chili or salsa.

Wear denim or western to celebrate Jim's style.

• Traveling family/friends gather at the Hillsboro Community Centre between 9:00 and 9:45 AM for morning coffee, snack bites, and restrooms before the Memorial starts at 10:00 AM.

• Hillsboro Community Centre, 158 Elenore Street, Hillsboro, NM 88042.

• **Videos of events will be posted later in the day on June 11.** Live-streaming is not reliable in Hillsboro. Memorial videos, photos, and postings will remain online. Search <https:// kirikosfamilyfuneralhome.com> for Jim Werker.

• New Mexico Chilli Buffet - A crockpot of your favourite red or green chili is welcome.

• Honour Jim's love of Chilli with a favourite hot sauce or salsa!

• Jim-stories, tributes, comments - several options. Share aloud during the Chilli Buffet. Write on a card to be compiled into a memory book. Search Jim Werker and click on Guest Book at https://kirikosfamilyfuneralhome.com

• View the obituary, memorial tributes at https://kirikosfamilyfuneralhome.com