TROGalong - 2013

Proceedings of the 29th biennial conference of the Australian Speleological Federation

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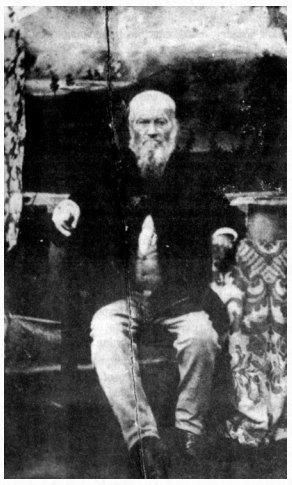
About the venue

A brief historical background

Galong, as we know it, would never have been but for the events of the night of Thursday, 7 September 1815 in far off Ballagh, Co Tipperary. Farmer Edward Ryan was convicted of insurrection and transported for his part in the destruction of an infirmary, which had been requisitioned by the militia for use as a temporary barracks. Fourteen men were brought to trial. One, Patrick Keogh, was hanged, and the other thirteen, including Ned Ryan and his cousin Roger Corcoran, were transported on the Surrey 2, arriving in the colony in December 1816.

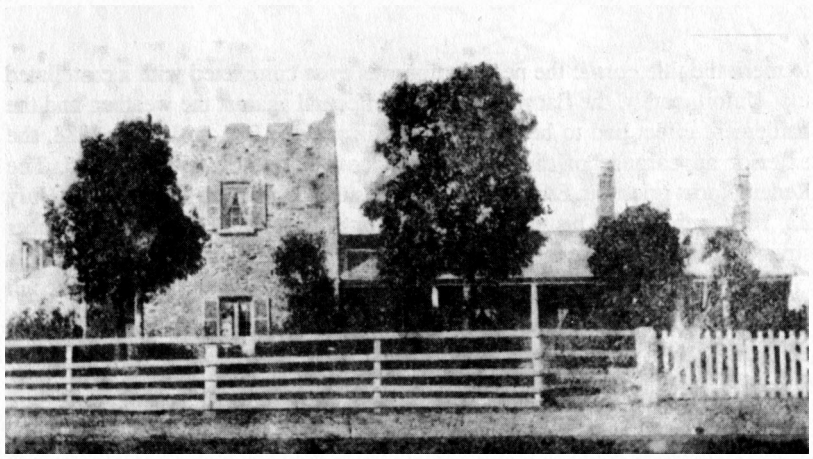


Edward 'Ned' Ryan 'King of Galong Castle'

Ned's employers after his arrival were the Deputy Surveyor-General James Meehan of Liverpool and William Crowe at Appin. From 1816 to September 1825, until he received his ticket of leave, he faithfully served his masters, who described him as being 'honest, sober and of industrious character'. Ryan family tradition has it that he squatted at Illalong, near present day Binalong, in 1826 but within a short time moved on to present day Galong, even further removed from civilisation. Three years later Governor Ralph Darling redefined the boundaries, setting up nineteen counties as the limits of lawful occupancy of land. Supported by a veritable Who's Who of respected settlers, Ned petitioned for a grant of land in 1830, but was refused due to a change in official policy. Unperturbed, he illegally squatted on huge acreages 'beyond the limits of location', taking up Galong, Gungewalla near Burrowa, Berthong and Nubba west of present day Murrumburrah and Geraldra near Wallendbeen.

The presence of the Catholic Church was evident from the early days of Galong. On one of his several visits, Bishop Bede Polding climbed Bushranger's Hill to erect a cross and bless the surrounding countryside. To mark the occasion he left his rosary beads on a she-oak atop the hill, which then became known as Rosary Hill.

Just over thirty years after his arrival, Ned's wife Ellen and their children Anastasia and John joined him at Galong in 1847. The present day homestead was erected during the 1850s and a two-storey extension, complete with castellation, at the eastern end about 1860. These stone embellishments no doubt caused Galong to become known as a 'castle'. By then Ned had secured from the Crown the 640 acres on which his homestead stood, and successfully alienated most of his land to his son John, and others. By 1866 Galong stretched across nearly 41,000 acres. With enterprise and determination Ned earned the reputation of being a hardwork-



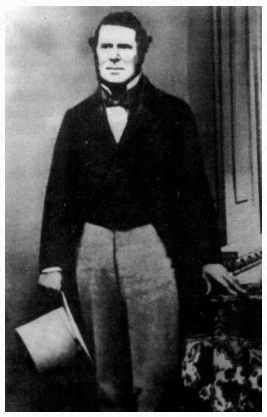
The house is a queer structure...the square at the left side is built with thick walls... with the top of the walls embattled like a castle.

Fr Edmund Vaughan, 1888

ing but fair man who gave endlessly to nearly every cause. Various family members migrated from Tipperary to the Galong area, including his brother's children, the Barry Ryans. Ned served on committees, his name appeared on almost every public subscription and his presence was noted at community events. Despite his gruff exterior he was without question an extremely generous man who was known to have supported some individuals for almost thirty years.

Of Ned it was written - 'His heart of gold was poorly hidden. There were people at Galong who had lived on his bounty for thirty years'.

Ned Ryan, whose wife predeceased him in 1856, died at Galong on 26 February 1871 and was buried in the cemetery for which he had given the land many years before. By the time of his death such was his reputation that he had acquired the sobriquets 'Patriarch of the Lachlan' and 'King of Galong Castle'. Ned's unmarried son, John Nagle Ryan, in addition to managing his own properties, took over the management of his father's holdings after Ned's death. John had been appointed a magistrate in 1854 and was elected as the member for the Lachlan in the Legislative Assembly in 1859, a position that he held until his resignation in 1865. During his lifetime he did much to further the interests of the residents of the Galong–Binalong–Burrowa area.



Hon John Nagle Ryan MLA 1815–1887

The Ryan vault erected in Galong cemetery in 1887.

His sudden death in January 1887 and the terms of his will set the future direction of Galong. In his will he bequeathed Galong House to his sister Anastasia Barry Ryan during her lifetime and upon her death the homestead and 800 acres of land to the Cisterian Monastery at Mount Melleray, Waterford, Ireland. If not accepted by them it was to pass to the Redemptorist Fathers at Waratah, NSW on the condition that it always remained the property of the Catholic Church. Ballyryan, his Boorowa property, was subsequently sold.

As instructed in John's will, a family vault was constructed in Galong cemetery, as was the stone wall surrounding the cemetery, and in late May 1887 the remains of Ned, Ellen and John were re-interred there. The three Ryan cousins Anastasia, Lawrence and Edmund Barry Ryan continued to live with Anastasia at Galong.

Anastasia Nagle Ryan carried on her father and brother's tradition of offering hospitality to strangers, providing substantial sums to the church and various charities. A second two-storey extension was added to the homestead in 1889 to provide a chapel and accommodation for a visiting priest. Deeply religious, she also followed Irish customs particularly in relation to the observance of wakes for the dead. She passed away in July 1900. With no definite decision as to the future of the property, Ned's nephews, Edmund and Laurence Barry Ryan, who died in 1905 and 1910 respectively, and their sister Anastasia Barry Ryan, who passed away in 1914, continued to live there.

Anastasia Barry Ryan, the last family member to live at Galong House.

After the death of Anastasia, the last remaining Ryan at Galong, the property became the subject of a 'friendly' court case, in which the Redemptorists sought to occupy the property after the Cistercians had declined to accept the bequest. The Court decided in favour of the Redemptorists and the property was transferred to them. The Order established a monastery dedicated to St Clement Hofbauer in 1918 and later a boarding school for boys.

The monastery is a large two–storey brick building, which with later additions, now holds within its embrace the original and unpretentious, pioneering homestead built by Irish convict Ned Ryan in the 1850s. With the addition of the Retreat Centre, the site has been much altered since it began life as Ned Ryan's squattage. The college closed in 1975 and its doors reopened as a popular Retreat Centre. It has been a Redemptorist ministry for ninety-five years.

In 2005–7 the Galong site entered a new phase with the overall refurbishment of the monastery and the addition of new accommodation and modern conference facilities. In addition to retreatants the Centre is available to community and corporate groups who seek a venue with a difference.

The most significant improvement has been the restoration work undertaken on Galong House, which now houses a dining/conference space, museum and library. The centre was successful in gaining a Community Heritage Grant in 2006 which enabled a conservation survey, significance assessment and preservation training workshop to be held for volunteers of several local heritage groups. Work in recent years has seen the library undergo significant improvements with the sorting and re-shelving of the collection. Students from the Donald Horne Institute at the University of Canberra are gaining practical experience in a diverse collection as it is identified, catalogued and digitised. The new exhibition 'an abiding presence ...' will open in the refurbished museum will open in mid 2013.

The approaches to the homestead have been re-landscaped with plantings appropriate to the period of occupation by the Ryan family. The rural landscape is also undergoing rejuvenation through the work of the Friends of St Clement's, who have established a sponsored tree planting program, to create an environmental sanctuary and reduce the dryland salinity that affects parts of the property.

St Clement's continues the Ryan tradition of hospitality to all and is very much the heart of the Galong rural community providing nourishment for body and soul.

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Further information: http://www.stclement.com.au

Galong House after restoration, 2007.

1

Contributed Papers

The Tasmanic caves of eastern Australia

Armstrong Osborne
University of Sydney

Caves occur in Palaeozoic limestone from the southeastern corner of Tasmania to Mitchell-Palmer in north Queensland. These caves are developed in mostly small bodies of limestone in which surface karst features are relatively less significant than caves. The caves and the karsts in which they occur have many features in common. Many of them intersect palaeokarst, have complex histories with multiple periods of development (post-palaeokarst) caused by a variety of processes. They often have an early hypogene stage followed by multiple paragenetic stages. Some sections of the caves are extremely old. Very often these caves are disconnected from the present hydrology, some never intersect the water table while others have no obvious stream sink or spring.

This presentation takes a continental scale view of eastern Australian caves, suggests sites for international comparison and looks at where research might be heading.

Video
http://nswsc.caves.org.au/trogalong/video/Tasmanic-karsts_Armstrong-Osborne.avi

Gap Creek - Boulder Caves

Garry K. Smith

Newcastle and Hunter Valley Speleological Society

Abstract

The caves at Gap Creek have been created by many large boulders, which originated from the cliffs above and tumbled down the slope to congregate in a perennial stream gully near the end of Bangalow Road. The voids between these large boulders have formed a network of small caves which are now home to a wide variety of flora and fauna.

Gap Creek is located in the Watagan Mountains which form part of the Great Dividing Range to the west of Newcastle. The mountains in this vicinity are typically characterised by flat ridgelines, numerous sandstone cliffs, steep slopes and deeply fissured gullies. The steeply sloping valleys are eroded from sandstone and conglomerate bedrock. In many places 30 to 50 metre cliffs tower above, while other parts of the valleys have steep scree slopes covered in dense rain forest. Large boulders which have broken free of the cliffs over time are now scattered amongst the forest, with greater numbers found in the Gap Creek tributary gullies.

Introduction

This paper discusses the geology, vegetation and recent history of the Gap Creek catchment and details two of the boulder caves in the area. While the caves are relatively small compared to other know caves of this type around Australia, the Gap Creek caves are important as habitats for a variety of fauna which rely on the micro climate found beneath the rainforest canopy and within the caves.

Location

The caves are located approximately 5 kilometres north of Martinsville and approximately 31km West of Newcastle in NSW, at an elevation of 220 metres ASL. The two caves described in this paper are within the Watagans National Park in a tributary gully of Gap Creek, which feeds into Dora Creek and eventually Lake Macquarie. Other boulder caves are located along Gap Creek above the Gap Creek Falls (Figure 1). About 1 km to the south-west of the caves is the National Park boundary and an abrupt end of the rainforest. A fence line marks the transition to private pastoral properties now cleared of the natural vegetation.

Access and amenities

The caves can be accessed from Mount Faulk and Bangalow Roads which enter the Watagans National Park from the South-East (Figure 1). The roads are unsealed and can become very boggy in wet weather, hence National Parks and Wildlife Service (NPWS) sometime close the roads. For further details on access etc, contact the Newcastle and Hunter Valley Speleological Society. P.O. Box 15, Broadmeadow, N.S.W. 2292, Australia.

There is a free public camp ground within several hundred metres of the caves. Facilities include pit toilets, gas BBQs, rubbish bins and walking tracks with some interpretive signs along the way.

There are several lookouts with excellent views, within a short driving distance of the Gap Creek picnic area. These include the Monkey Face, Heaton and Hunter lookouts.

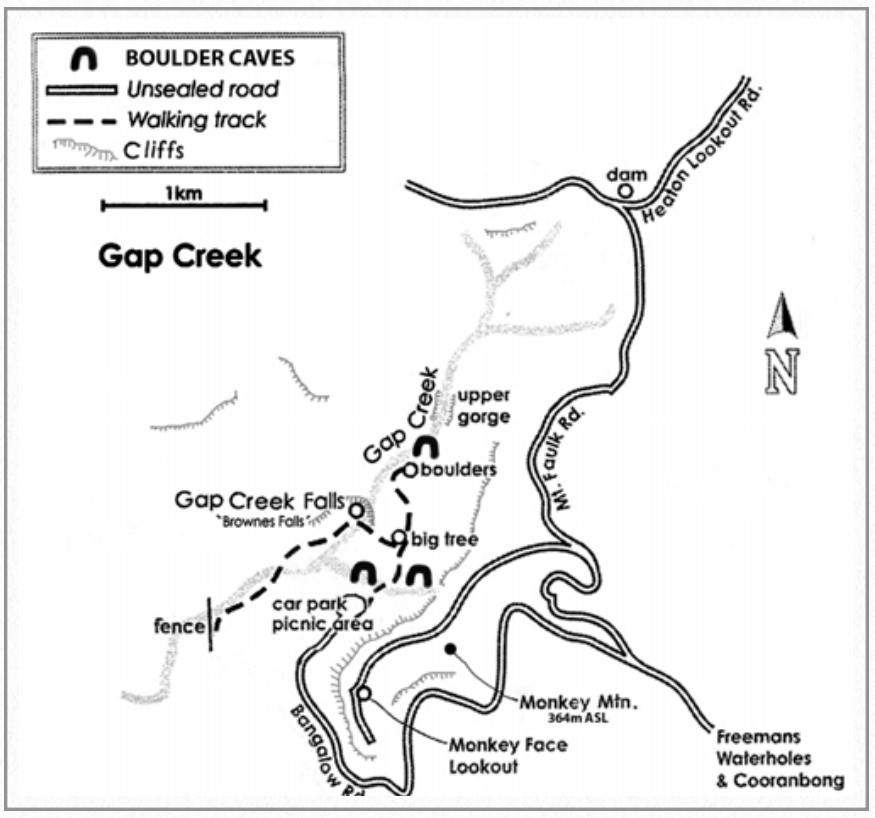

FIGURE 1 *Location of Caves within Gap Creek Valley*

Geology

The Watagan Mountains make up a small portion of the Great Dividing Range which stretches for more than 3,500 kilometres down the length of Australia's east coast. The exposed sandstone and conglomerate rocks which make up the cliffs in the Watagan's Gap Creek area, were originally laid down as part of the Sydney Basin strata.

"Generally speaking the sedimentary history of the Sydney Basin is the result of a marine transgression at the end of the Late Palaeozoic glaciation, followed by a marine regression during the Late Permian and Triassic times. Major sedimentation ceased about the middle of the Triassic period." (8)

Subsequent tectonic events lifted the strata to form the Great Dividing Range about 50 million years ago. "More recently, volcanic flows covered large areas of the mountains in basalt. These have largely worn away, leaving only occasional outcrops on the high peaks" (9).

Erosion over millions of years has created the present topography of the Watagan Mountains, which is characterised by flat ridgelines, numerous sandstone cliffs, steep slopes and deeply fissured gullies. The soils are generally acidic sandy loams with low to moderate fertility, and are highly erodable.(4)

The Watagan Mountains consist of thickly bedded sandstone with lenses of conglomerate, dominated by the Hawkesbury and Narrabeen Group sandstones common within the Sydney Sedimentary Basin. (4)

These are Triassic sedimentary rocks formed between 208–245 million years ago.(3)

Hydrology

The unnamed tributary of Gap Creek where the caves are located, is fed from water runoff and seepage from Monkey Face cliffs. This tributary creek flows into Gap Creek downstream of the 40 metre high Gap Creek Falls (previously known as Browne's Falls), then into Dora Creek and Lake Macquarie. The water percolating through the boulder caves is typically crystal clear.

Origin of the caves

Over time many large chunks of the conglomerate and sandstone cliffs have broken away and the boulders rolled down the slopes to collect in the gullies (Figure 2). The caves are created by these large boulders resting in the perennial stream gully near the end of Bangalow Road. The largest of these boulders is approximately the size of a double-decker bus. The voids between the boulders have formed a network of small caves (Figure 3).

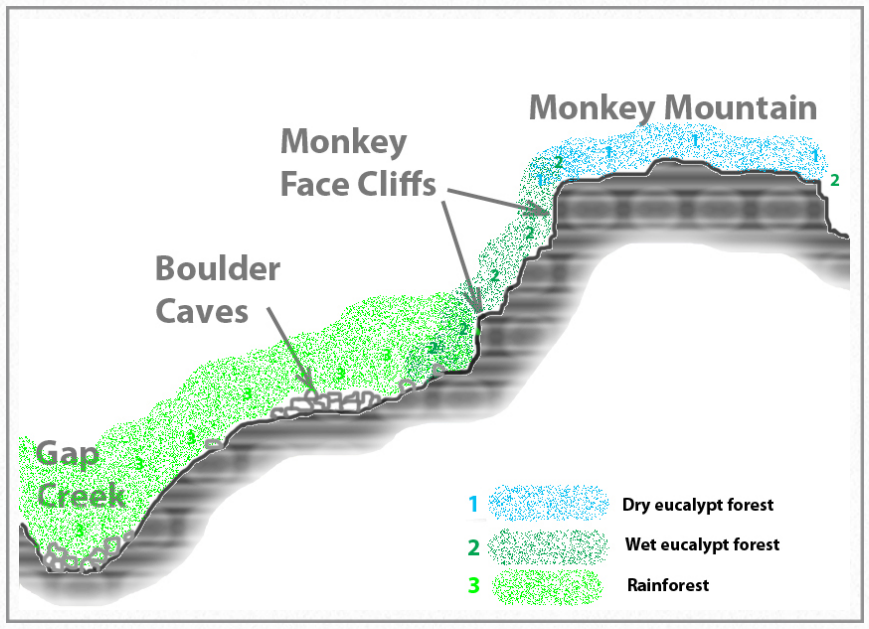

FIGURE 2 *Section through Gap Creek and Monkey Mountain, showing location of caves and typical vegetation cover.*

FIGURE 3 *Cave created by boulders in a perennial creek bed.*

Many of the boulders contain substantial eroded concave surfaces which are consistent with the type of wind and moisture weathering caves occurring in nearby cliff faces (Figure 4). A number of the boulders containing significant weathered concave surfaces have come to rest with the weathered concave surface facing down so that there are now single chamber caves under the boulders. There are also several examples of these weathered surfaces on boulders which make up the two caves described in this paper.

FIGURE 4 *Cave under a large boulder which was originally a weathered cliff cave before breaking free of the escarpment and tumbling down into the gully.*
Photo G.K. Smith

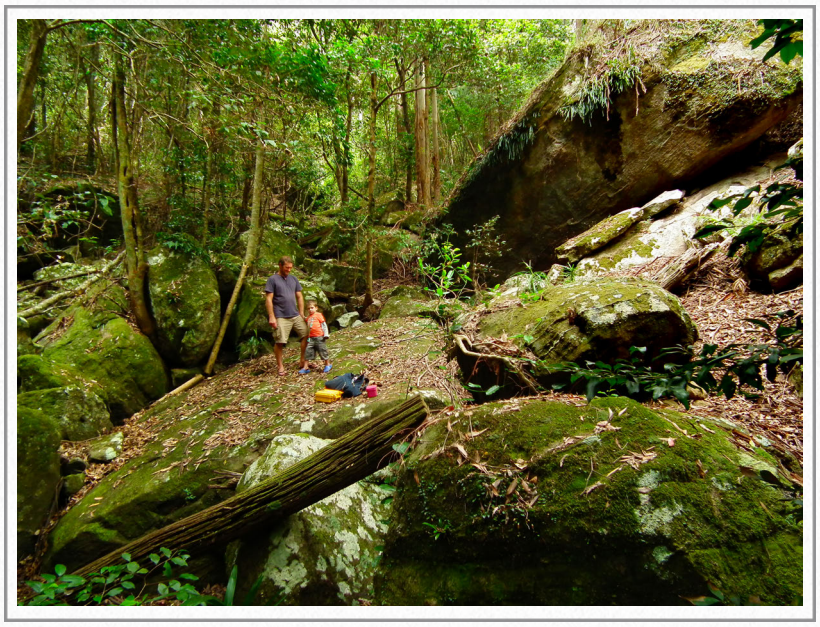

FIGURE 5 *Boulders in gully which have created part of Bangalow Rock Pile Cave (I6E-68).*
Photo G.K. Smith.

The caves

The largest known boulder caves in the area are near the end of Bangalow Road. They are the Bangalow Rock Pile Cave (I6E-68) and the Log Jam Cave (I6E-69). Cave maps are provided at the end of this paper (Figure 21, 22). Both of these caves and several others located on Gap Creek above the falls are at an elevation of ~260m ASL.(7) The caves contain several permanent pools fed by the perennial stream and water seepage from surrounding soils and bedrock. Hence a high humidity is maintained within the caves all year round.

Bangalow Rock Pile Cave (I6E-68)

This cave is the most significant of the two caves described in this paper (Figure 5). There are four known entrances and a total survey length of 60m. It consists of several chambers connected by low crawl- ways along a perennial stream bed. In many places throughout the cave, the boulders are resting on exposed bedrock, washed clean by turbulent water flow during times of flood (Figure 6).

Several small chambers branch off the main passages at different levels. The upper levels are generally dry and frequented by bats while the lower levels at very damp and favoured by Glow-Worms.

A perennial stream flows through this cave, however even during drought periods there are a number of small permanent pools which retain water. During extended periods of rain the stream increases to a substantial torrent making access to most of the cave near impossible.

FIGURE 6 *Inside Bangalow Rock Pile Cave (I6E-68).*
Photo G.K. Smith.

Entrance No.4 is the most obvious entry point, however this is the most difficult entrance due to the 3.5m vertical drop and smooth boulder surfaces. This entrance is directly above one of the larger chambers in the cave and allows some light to enter the cave, however direct sunlight rarely penetrates the high forest canopy.

Log Jam Cave (I6E-69)

This cave has five known entrances and the total survey length is 37m. The main entrance is quite spacious and easy to access. There is a large section of exposed bedrock leading from the main entrance down to a pool. From here several crawl-way passages with mud floors, can be followed to other exits from the rockpile (Figure 7). After floods the crawl-ways may be full of forest debris, however this can easily be re-

FIGURE 7 *Cavers exiting via No.4 entrance of Log Jam Cave (I6E-69).*

Photo by G.K. Smith

moved. Leeches have often been encountered near the exits of this cave.

No bats have been observed in this cave despite there being a couple of avens up to 3.5 metres in height.

Fauna

Due to the perennial stream and a number of permanent underground pools located in the cave's dark and twilight zones, a diverse range of aquatic life can be found within the caves. These include: leeches, freshwater snails, fishing spider (Dolomedes sp.) freshwater shrimp, yabbies, tadpoles, diving beetles and mosquito larvae to name a few. The caves also supports a healthy population of glow-worms (Arachnocampa richardsae), Leaf Tailed Gecko (Phyllurus platurus), millipedes, spiders, harvestmen, weta (Australotettix montanus), Granny's Cloak Moth (Speiredonia spectans) and numerous other species of insects. (Figures 8-12)

At various times of the year, up to 20 Eastern Horseshoe Bats (Rhinolophus megaphyllus) have been observed in the Bangalow Rock Pile Cave (Figure 13).

Above ground there are over 150 native animals and 130 different species of birds recorded within Watagans National Park, some of which are listed as endangered or vulnerable species under the Threatened Species Conservation Act 1995. These include the following animals; brush-tailed rock wallaby, yellow-bellied glider, koala, spotted-tailed quoll and two bat species the large-eared pied bat and the yellow-bellied sheathtail-bat. (2)

FIGURE 8 *Granny's Cloak Moth (Speiredonia spectans)*

FIGURE 9 *Glow-worm (Arachnocampa richardsae)*

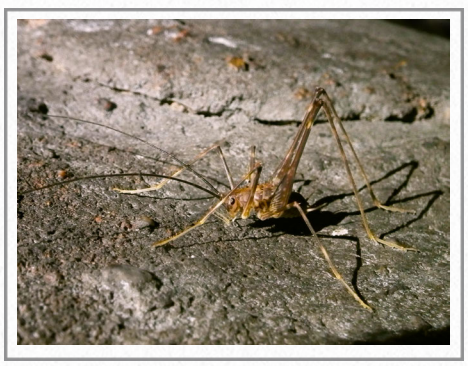

FIGURE 10 *Weta (Australotettix montanus)*

FIGURE 11 *Huntsman spider (Heteropoda jugulans)*

FIGURE 12 *Leaf Tailed Gecko (Phyllurus platurus)*

FIGURE 13 *Eastern Horseshoe Bats (Rhinolophus megaphyllu)*

All fauna photos above, were taken in the Gap Creek boulder caves by G.K. Smith.

Flora at Gap Creek

Within the Gap Creek catchment, there is a wide variety of vegetation ranging from Rainforest in the gullies through to 'Wet Eucalypt Forests' and 'Dry Eucalypt Forests' on top of the ridges (Figure 2). The transition between the vegetation types can be very abrupt and occur due to cliff lines and valleys causing micro climates, as well as soil depth. All three vegetation types occur within a several hundred metre radius of the caves.

Due to the vast number of plant species which comprise the forest types, it would be too large a list to add to this paper.

The NSW Government - National Parks website provides the following very good general description of the three forest types within the Watagans National Park. For more detail refer to [www.environment.nsw.gov.au/NationalParks/parkVegetation.aspx?id=N0133]

Rainforest

Smaller areas of warm-temperate sub-tropical rainforest and paperbark palm forests occur in sheltered gullies and creeklines (Figure 14 & 15). Typical rainforest species include lilly pilly (Acmena smithii), sassafras (Doryphora sassafras), brush cherry (Syzygium australe), wild quince (Guioa semiglauca), coachwood (Ceratopetalum apetalum) with tree ferns (Cyathea australis, C. leichhardtiana, C. cooperi), climbing vines and epiphytes common beneath the canopy. Isolated stands of red cedar (Toona ciliata) and Illawarra flame trees (Brachychiton acerifolius) remain in more remote areas. (2)

FIGURE 14 *Rainforest vegetation in Gap Creek. Photo by G.K. Smith*

The paperbark palm forests contain a number of melaleuca species (Melaleuca biconvexa and M. linariifolias) with white bottlebrush callistemon salignus) and cabbage tree palms (Livistona australis).(2)

Wet eucalypt forests

Watagans National Park and adjacent Jilliby State Conservation Area contain similar vegetation types. Tall moist eucalypt forests are widespread in the reserves and predominately occur on the higher slopes below the ridge line down to the fringes of the rainforest. They commonly contain turpentine (Syncarpia glomulifera), mountain blue gum (Eucalyptus deanei), white mahogany (E. acmenoides), Sydney blue gum (E. saligna), blue- leaved stringybark (E. agglomerata), blackbutt (E. pilularis) and grey gum (E. propinqua) with warm temperate rainforest influences dominating the understorey of these communities.(2)

Dry eucalypt forests

This forest type is found predominately on the ridge top where soil depth is shallow. Forest oak (Allocasuarina torulosa), Sydney peppermint (E. piperita), broad-leaved white mahogany (E. umbra), large fruited red mahogany (E. scias subsp. scias), smooth-barked apple (Angophora costata) and red bloodwood (Corymbia gummifera) are common in the drier forest areas with understoreys varying from open dry and grassy, to dense shrubbery.(2)

Land surrounding the National Park is use predominantly for forestry, with grazing and smaller rural residential "hobby" farm lots in the foothills and valleys below. (1,1a)

History of the area

The original inhabitants of the Watagan Mountains are the Awabakal and Darkinjung Aboriginal peoples. Evidence of their occupation can be found throughout the area in the form of occupation and art sites, engravings and axe grinding grooves.(1,1a)

European use of the area began in the early 1820s, with the arrival of the cedar getters. Hardwood harvesting followed, bolstered by the construction of the nearby Newcastle rail link in the 1850s, the availability a of timber supply route to the coast via Dora Creek and the growing coal mining industry's need for timber.(2)

Timber was the backbone of the local economy and four large steam-driven timber mills were operating in the area in the 1870s.(6) The Cedar trees grew in abundance throughout the Watagan Mountains and was a very sort after timber for furniture. The early (colonial cedar) trade saw most of the cedar shipped off to England to supply an insatiable market for fine-Softwoods. (7, 7a)

The early roads in the mountains were developed from the original bullock tracks used to extract logs. Timber production from the mountains was increased through the construction of tramways, loading points and elaborate mechanical flying foxes to lift or drag logs to the sawmills.(2)

The demand for railway sleepers generated by the construction of the Sydney-Newcastle railway caused a boom up till its completion in the late 1880's.

In 1916 the creation of the Forestry Commission (now Forests NSW) saw much of the Watagan Mountains set aside as State Forest (2). By 1936 the Forestry Dept had resumed all of the land and declared the whole of the Watagan Mountains as a forest reserve for the growth of timber(7, 7a).

At this time, the newly created Olney State Forest encompassed 44,000 hectares and included the area where the caves are located. Large plantations of Blue-Leafed Stringy Bark and Blackbutt were planted in parts of the forest during the 1960s and 70s, to supplement selected timbers.(2)

During World War II the forests were almost entirely stripped of their softwoods, particularly coachwood, which was used for the Diggers' .303 rifle and for the construction of the Mosquito fighter plane. (6)

FIGURE 15 *Strangler Fig and vines growing over a boulder in the Gap Creek rainforest.*

Photo by G.K. Smith

Monkey Mountain and Monkey Face lookout which overlooks the Gap Creek valley containing the caves, is named after an old lead bullock from the timber-getting days. Monkey was owned by the Browne's family, who were among the early settlers, timber-getters and sawmillers in the area. There are two stories circulating about Monkey. One was that Monkey liked to hide, in its spare time, on a mountain shelf below the top of the cliff line(6) and the other is that it led the whole bullock team over the cliff to their death.(5) Hence the names Monkey Mountain and Monkey Face (Figure 1).

The 40 metre high Gap Creek Falls has only been known by that name since about the mid 1990's (Figure 1). Historically they were known as Browne's Falls (named after the aforesaid pioneering saw milling family in the Martinsville valley). After rain the water topples in wide sheets and veiled cascades over the falls into the broad plunge pool below. The grotto at the base of the falls is very similar to many found in the Blue Mountains.

The Watagans National Park covering an area of 7,798 hectares, was created through the enactment of the Forestry and National Park Estate Act 1998 on 1st January 1999, under which parts of three state forests were combined and transferred to the National Parks and Wildlife Service (NPWS).(1, 1a). This included the Gap Creek Valley previously under the control of the NSW Forestry.

Another 47 hectares was added to the National Park in 2007. (1a)

A draft plan of management for Watagans National Park was placed on public exhibition from 5th December 2008 until 30th March 2009. The final management plan was adopted by the Minister for 'Climate Change and the Environment' on 10th December 2010.

Caves discovery and visitation

No written account of the caves or their discovery was uncovered during the research for this paper, however the author has personally known of the caves since the mid 1970's and their existence was known by a few Scouting leaders at the time. The caves have been explored by groups of Venturer Scouts as part of their Initiative Course between the late 1970's through to the late 1990's.

Since 2000, the caves have been visited on several occasions by members of the Newcastle and Hunter Valley Speleological Society Inc (NHVSS) (Figures 17, 19, 20). However, the location of the caves is not widely known by the general public, thus visitation numbers are relatively low.

The general public frequently utilise the Gap Creek rainforest walking tracks within the Watagans National Park. The nearby cliff faces below Monkey Face are frequently utilised by rock climbers and abseilers as there is easy access tracks from top to bottom around the exposed rock faces (Figure 16). NPWS have also encouraged the general public to visit the forest, waterfalls and walking trails, by provided free camping sites and well equipped picnic areas in the vicinity of the attractions.

Climate

The official Bureau of Meteorology records show that the Olney State Forest has a yearly temperature range between 0°C and 37°C. However, the average temperature range is between 16°C and 30°C in summer and between 5°C and 16°C in winter. The area's highest recorded rainfall is 91.4mm during one day and the average annual rainfall is approximately 1.5m.

Due to the abrupt transition in elevation from the Eastern coastal lowlands at < 100 m, the Watagan Mountain ridges at > 400m receives a higher than average rainfall. Nestled between the mountains, the Gap Creek valley, also receives a high average rainfall as well as the runoff from the surrounding ridges. In addition, the high mountain ridges protect the valley from severe winds, which makes it ideal for growth of high canopy rainforest vegetation. These conditions have created a relatively moist micro climate beneath the rainforest canopy and within the caves.

Hazards

There are three hazards worthy of mention.

1. Leeches are very prevalent throughout the forest, particularly during and after wet weather.
2. Ticks are commonly found in the dryer parts of the forest, in particular where there is thick low level vegetation.
3. The unsealed gravel access road can become very slippery and even boggy after extended periods of rain. NPWS may close Bangalow Road to vehicles during extended periods of rain.

Acknowledgements

Thank you to the NSW ‘Department of Environment and Climate Change’ and ‘National Park & Wildlife Service’ for the use of information, as detailed on their websites.

I would like to especially thank Jodie Rutledge for her suggestions and proof reading of this paper.

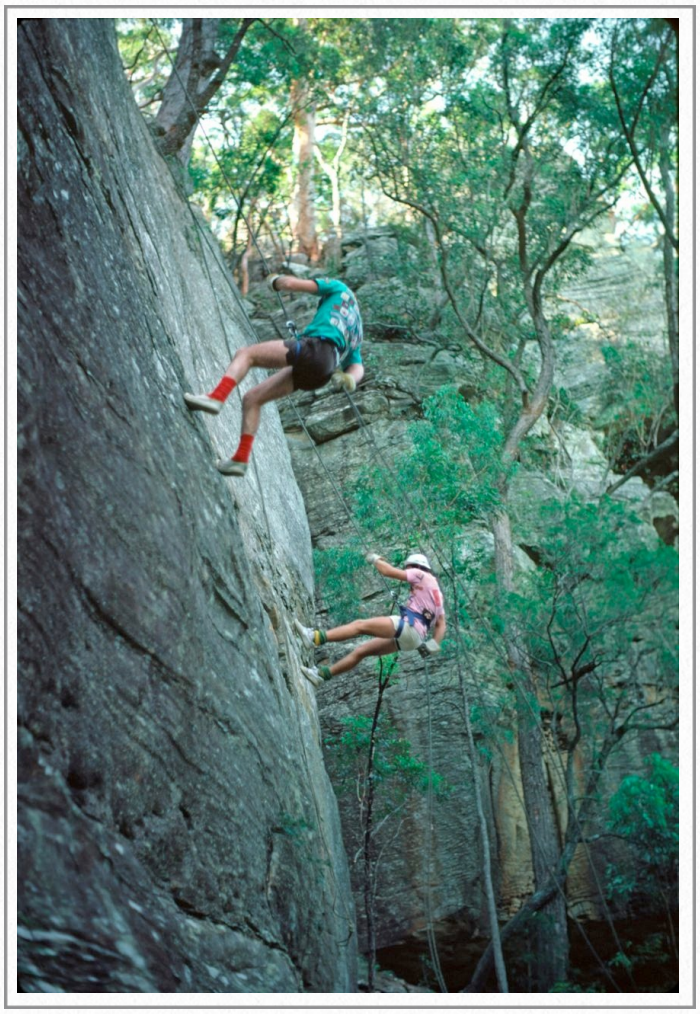

FIGURE 16 *Abseilers on the cliff below Monkey Face lookout*

Photo by G. K. Smith

FIGURE 17 *Caver negotiates a squeeze in Bangalow Rockpile Cave*

Photo by G. K. Smith

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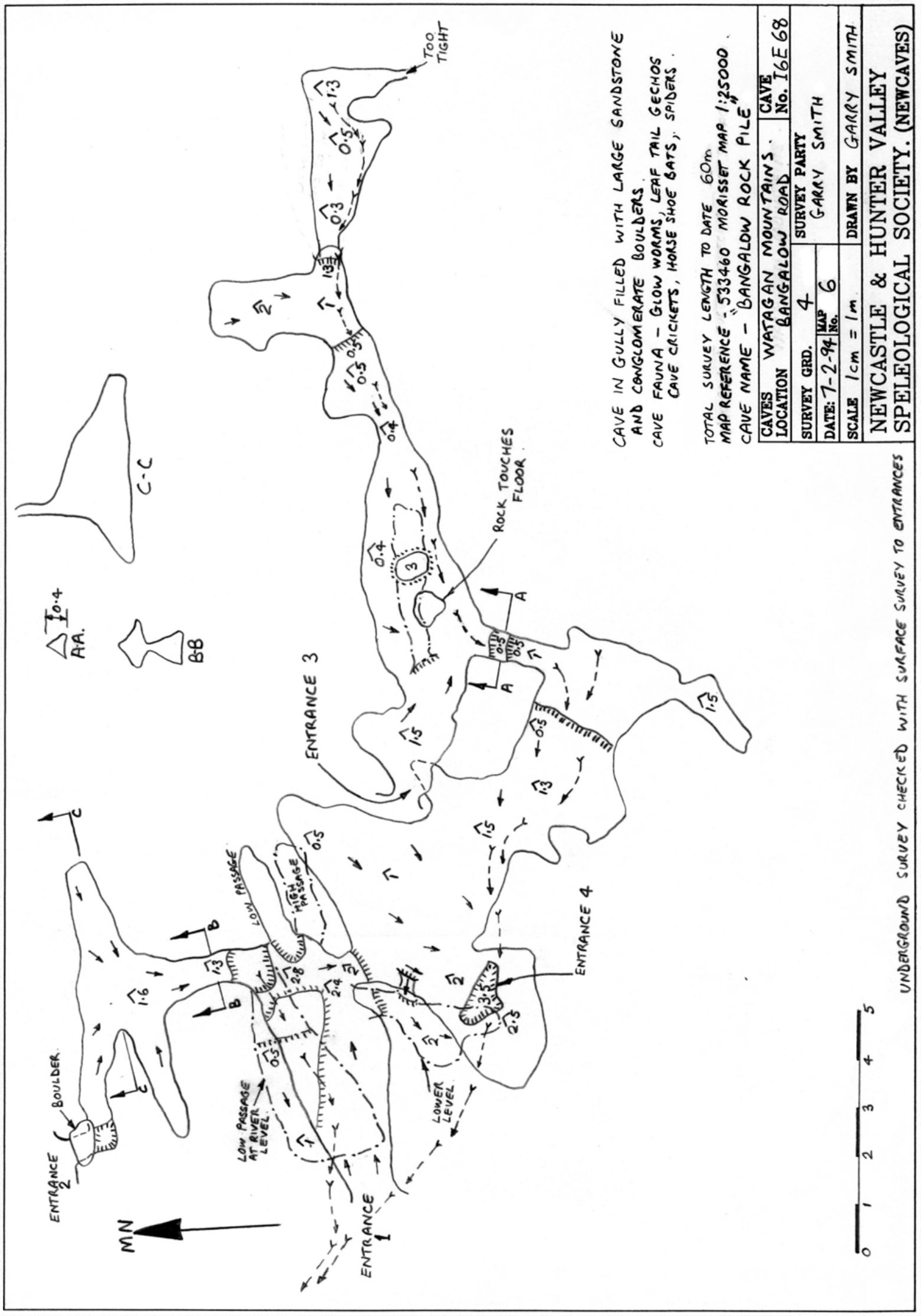
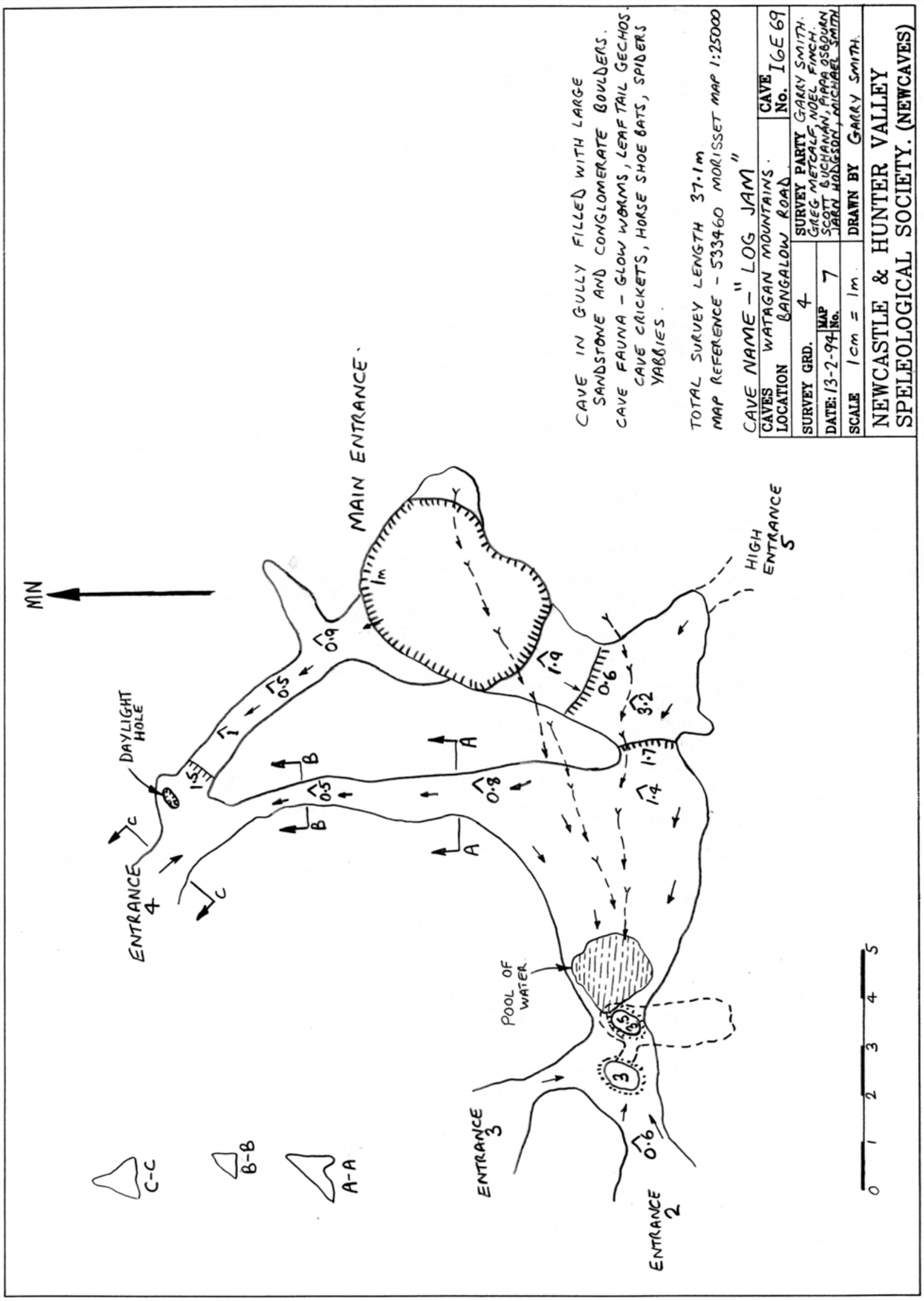
FIGURE 19 *The author exploring a boulder caves at Gap Creek. Photo G.K. Smith*

FIGURE 20 *Looking out the entrance of a boulder cave on Gap Creek. Photo by G.K. Smith*



Bangalow Rock Pile Cave (I6E-68)

FIGURE 21



Log Jam Cave (I6E-69)

FIGURE 22

CO_2 fluctuations in two Wombeyan caves and implications for Speleothem growth

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Abstract

CO_2 is being seen as an increasingly important factor in calcite development and hence speleothem growth. However, a better understanding is needed in order to fully understand the use of speleothems as recorders of palaeoclimate information.

Despite several cave CO_2 studies undertaken in the Northern Hemisphere, each emphasising the specificity of each site, there is a paucity of data on CO_{2cave} distribution in the southern hemisphere, especially in Australia. To date only one NSW CO_{2cave} study has been conducted and published and this study is the first to be undertaken at Wombeyan Caves.

Introduction

The objectives of my honours thesis were to measure CO_2 fluctuations throughout two touristic caves within the Wombeyan Caves Conservation Reserve, to determine preferential pCO_2 conditions for calcite growth, consider impacts of site hydrology on calcite (speleothem) growth and to investigate anthropogenic contribution to cave pCO_2.

Impacts on Calcite Development

The impacts on calcite development begin with the rainfall reacting with atmospheric and soil CO_2 produced by bioproductivity (Moore, 1962). The percolating waters dissolve CO_2 forming carbonic acid, which is the key driver of carbonate dissolution, until the fluid becomes saturated with respect to calcite. The now saturated dripwaters enter a cave with lower CO_2 partial pressure (pCO_2), preferentially, causing the CO_2 to degas and precipitate calcite as a speleothem (Moore, 1962). The rate of each of the aforementioned process will impact the hydrochemistry and equilibrium state of the dripwater which will determine the growth rate, geochemistry and petrography of the calcite (Fairchild *et al*., 2000; Frisia *et al*., 2000; Spötl *et al*., 2005). The pCO_{2cave} is known to impact the dripwaters ability to degas and deposit calcite, therefore preferable conditions for growth occur when pCO_{2cave} is lower than $pCO_{2dripwater}$. At CO_2 levels above the limestone threshold (2400ppm) the reaction reverses and dissolution occurs causing irreparable damage to the modern speleothems (Dragovich and Grose, 1990). As pCO_{2cave} has been known to show seasonal variability it can be assumed that during periods of lower CO_{2cave} (cooler months) would be preferential for the enhanced degassing of dripwaters and more conducive to calcite growth (Baldini *et al*., 2008). This implies that speleothems may preferentially record a winter climate signal, which will have implications for interpretation of palaeoclimate records.

Site Location and Climate

The Wombeyan Karst Conservation Reserve is located on a dissected plateau east of the Great Dividing Range, 125km SW of Sydney. The marble is approximately 200m thick and covers an area of 4km2. It is highly jointed providing important starting points for enlargement by solutional processes (McDonald, 2005).The two caves studied were Wollondilly and Kooringa. Wollondilly is a complex three levelled cave, with over a km of ladders and stairs, whilst Kooringa Cave is a small collapsed chamber. Local climate is warm to cool temperate but hydrology is highly variable and aseasonal rainfall patterns provides a constraint on calcite growth. Long term hydrology indicates that there is greater recharge in the cooler months where there is less evaporation. However, this is not always the case there can be lower precipitation in winter and high precipitation in summer depending on the El Niño Southern Oscillation conditions (ENSO). As an example, this year (2012) there was heavy rainfall in February and March, when the highest temperatures were recorded, and a water deficit occurred in the cooler months. At this site rainfall is strongly correlated to La Nina/El Niño phases. Since calcite deposition is also dependent on discharge and discharge is known to be ‘aseasonal’ at Wombeyan, speleothem growth rate at this site is also deemed to be highly variable. This has potential implications for derivation of climate histories from calcite precipitated from this drip and other similar drips at Wombeyan (McDonald *et al*., 2004).

Carbon Dioxide Measurements

Measurement of cave CO_2 levels was undertaken using a hand held Vaisala GM70 CO_2 monitor. Potential error by operator respiration was minimised by placing the probe in a designated area and the removal of the operator from the cave. Temperature, Humidity and Dew Point were measured synchronously with CO_2 using an EasyLog USB Probe. For the most part there appeared to be no strong relationship between CO_2 and other atmospheric conditions within the cave.

Two types of surveys were undertaken: Firstly, 8 hour surveys with readings taken at 20m intervals to quantify CO_2 distribution throughout the Wollondilly and Kooringa cave systems. This was performed on three occasions with the aim of quantifying seasonal cave CO_2 variability. And secondly surveys were undertaken initially overnight and then for more extensive periods to determine the impacts that the external diurnal temperature and pressure fluctuations had on the cave atmosphere.

Wollondilly Survey Results

The results of the Wollondilly surveys (Figure 1a-c) indicate that the CO_2 levels follow similar trends throughout the year. During each survey CO_2 levels are consistently higher in the Mulwaree Extension and lower in the Paddy Fields. The similarity between internal and external temperatures (±2°C) in April will decrease cave breathing by limiting the density driven exchange of air masses, from surface to cave and vice-versa. The possible high CO_2 build up in the upper passages are unequivocally characterized by the presence of roots penetrating through fractures in the cave, as the roots breathe and produce CO_2. This CO_2 is then trapped in the upper passages of the Mulwaree Extension due to the bottleneck that occurs upon entry to this area. Lower Wollondilly experiences the lowest levels of CO_2 because it is well ventilated. However, there is a slight yet consistently higher level of CO_2 in the Coronation Extension due to constricted flow. Due to an increase in contrast between external and internal temperatures (±6°C) increased cave breathing occurred in both July and in August and as a result there are consistently lower levels of CO_2 seen throughout the system due to continual effects of cave breathing. The findings of Baldini and others (2006) show a consistent increase in CO_2 with increasing distance from the entry. Comparatively, the CO_2 variations in Wollondilly Cave do not conform due to the complexity of the cave system. Overall it can be seen that CO_2 fluxes in Wollondilly

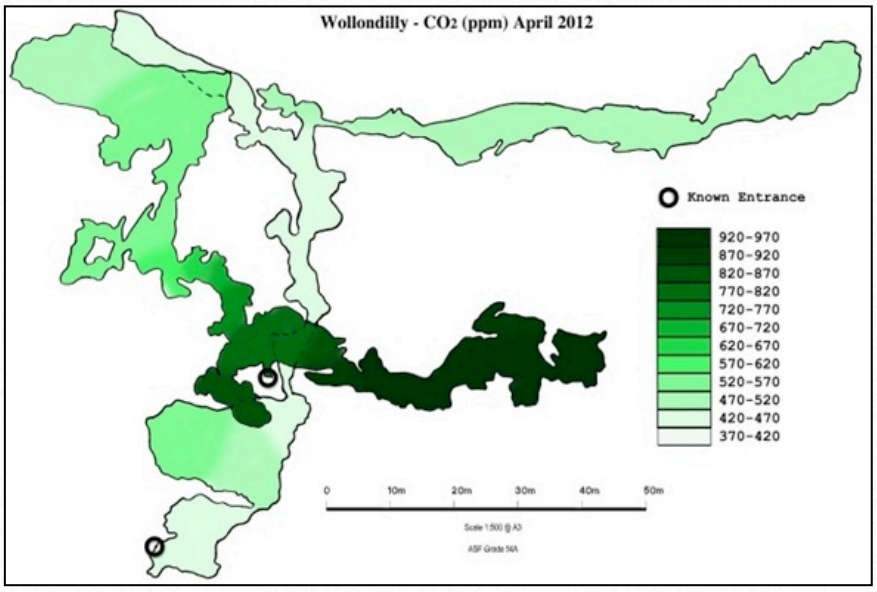


FIGURE 1 *a. Cave carbon dioxide (CO_2 ppm) distribution map for Wollondilly cave, April 2012.*

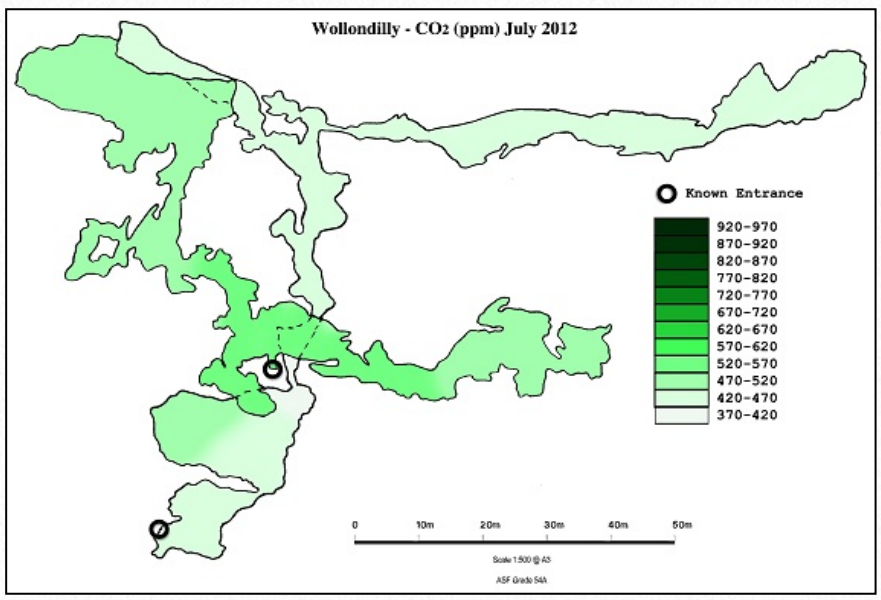


FIGURE 1 *b. Cave carbon dioxide (CO_2 ppm) distribution map for Wollondilly cave, July 2012*

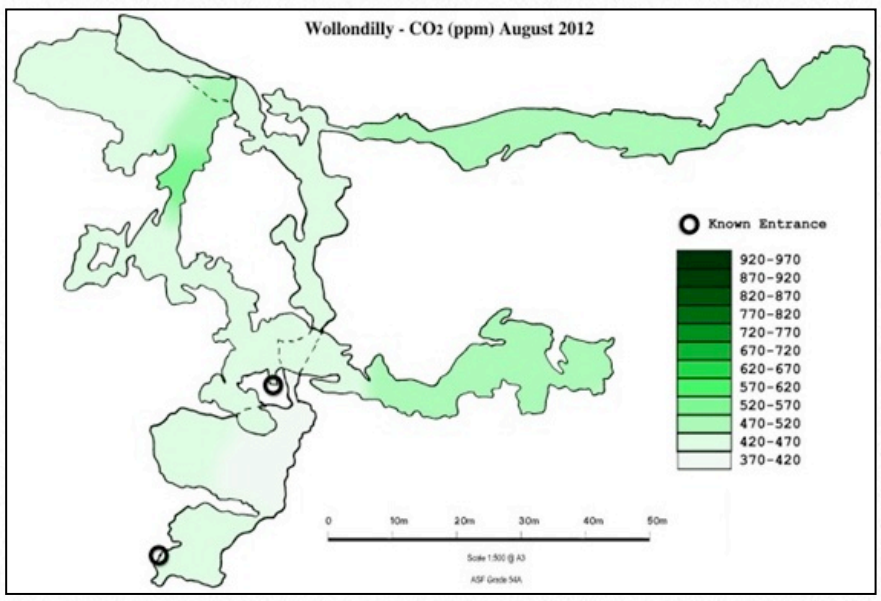


FIGURE 1 *c. Cave carbon dioxide (CO_2 ppm) distribution map for Wollondilly cave, August 2012.*

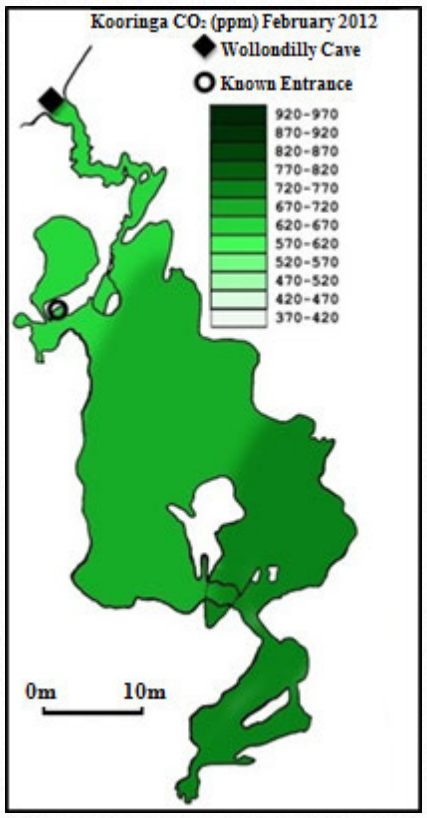


FIGURE 2 *a. Cave carbon dioxide (CO_2 ppm) distribution map for Kooringa cave, February 2012.*

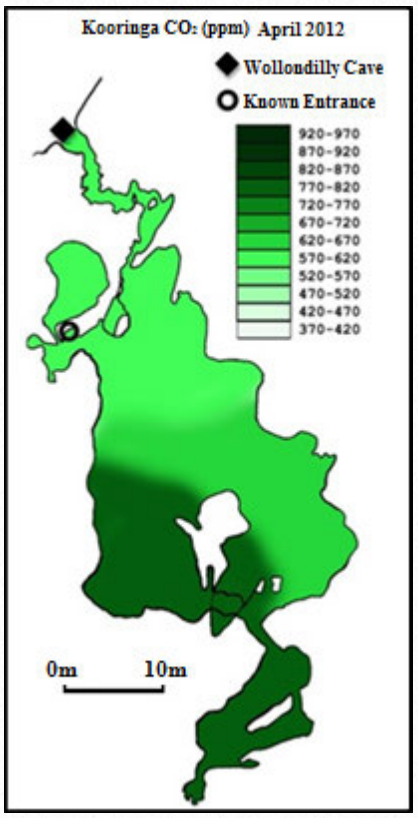


FIGURE 2 *b. Cave carbon dioxide (CO_2 ppm) distribution map for Kooringa cave, April 2012.*

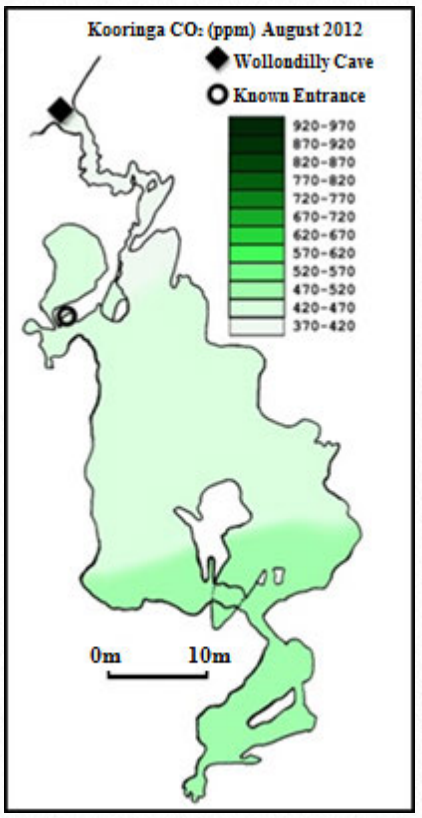


FIGURE 2 *c. Cave carbon dioxide (CO_2 ppm) distribution map for Kooringa cave, August 2012.*

Cave are constrained by the cave architecture and it is not sufficient to say that CO_2 concentrations increase with distance from entrance in this cave. The system is very complex and increased frequency of CO_2 surveys is recommended so as to quantify the CO_2 fluctuations.

Kooringa Survey Results

Unlike Wollondilly Cave, Kooringa Cave is a collapsed chamber and is open to the external atmosphere via an open gate and a tight connection to Wollondilly cave. Due to these features and the lack of tight passages CO_2 levels recorded are consistently lower than those recorded in Wollondilly and increase with distance from the main entrance, in line with the findings of Baldini *et al*. (2006). Three CO_2 surveys were carried out in Kooringa Cave (Figures 2a-c) and while trends remain the same a distinct change the levels of CO_2 during the colder months can also be observed in this cave. With a more consistent and complete data set than is acquirable in an honours year the potential seasonality of the pCO_2 of the caves would be more discernible. The limited findings infer that Wombeyan stalagmites may preferentially preserve a cold season signal due to the seasonal fluctuations in cave CO_2 and hydrology.

Anthropogenic CO_2 Input

An extended CO_2 survey undertaken in Upper Wollondilly (Figure 3) showed peaks occurring between the 8-11th of June, coinciding with the Queen's Birthday long weekend when there is an increase in visitor numbers to the cave. The constant presence of tourists in the caves limits the ability of the CO_{2cave} to return to its base levels. This, in turn, means that the input of anthropogenic CO_2 on the days following will steadily increase the 'base' level each day. Figure 3 indicates that the Mulwaree Extension took two days to fully recover from 3 days of intensive visitations. The location in which this survey was taken is bypassed by tourist groups. Inferring that the levels of CO_2 through the entire system must be impacted greatly in order for this section, which has

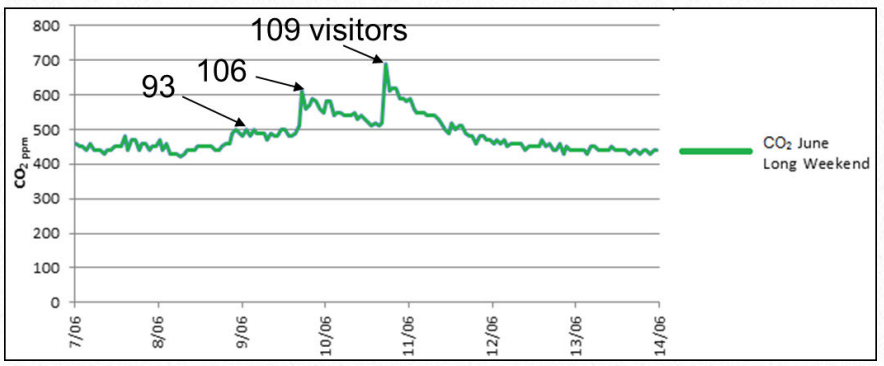
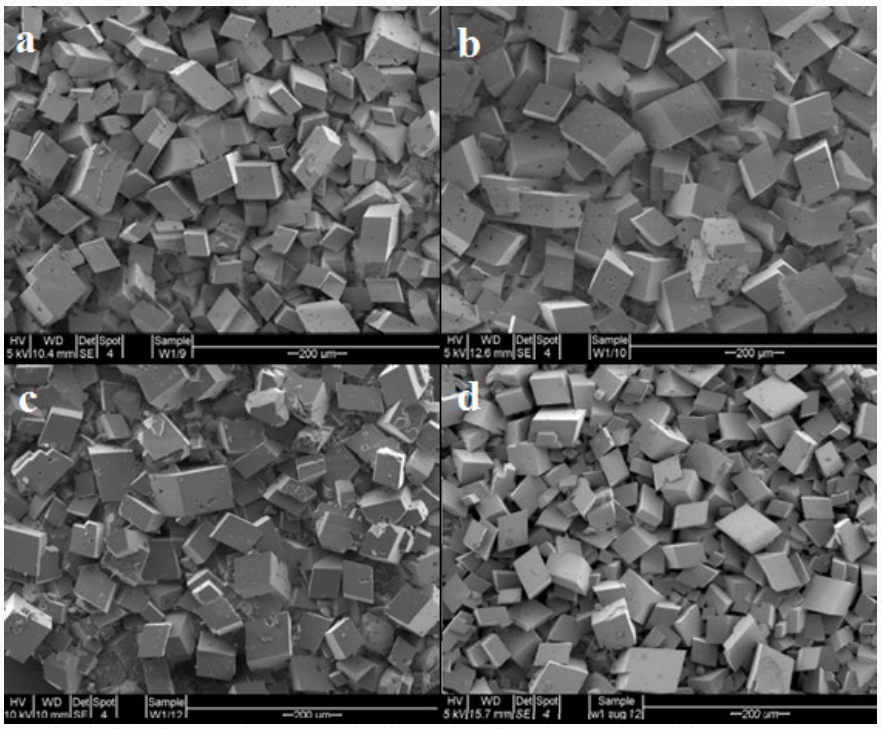
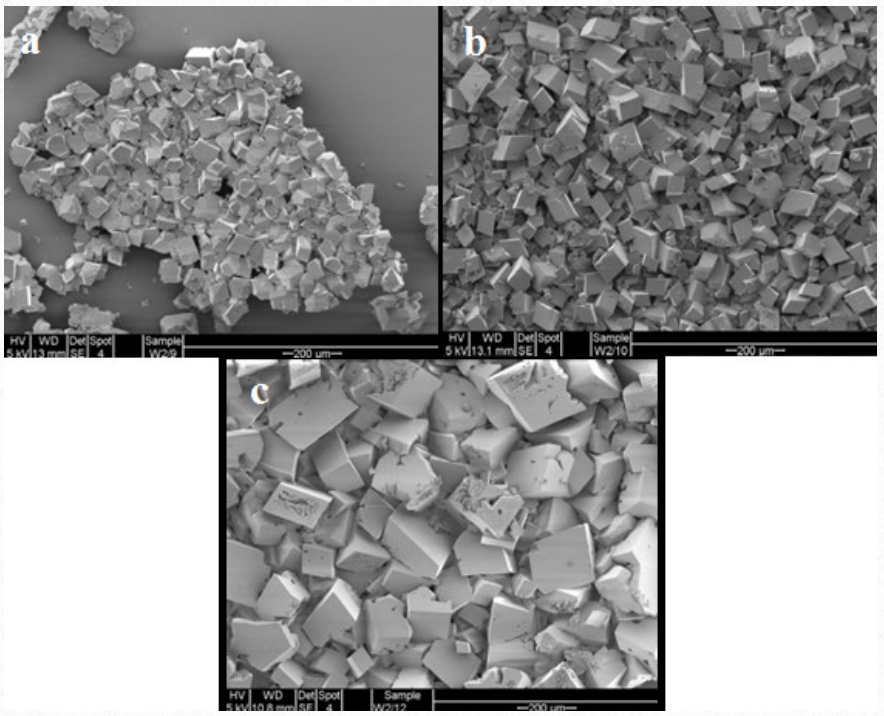


FIGURE 3. *Anthropogenic impacts on pCO_{2cave} due to increased tourist activity over the June long weekend, 2012. CO_2 values returned to baseline values within 36 hours.*



FIGURES 4 *a-d. SEM Images of Calcite samples collected from site W1 between 2009 and 2012.*



FIGURES 5 *a-c. SEM Images of Calcite samples collected from site W2 between 2009 and 2012.*

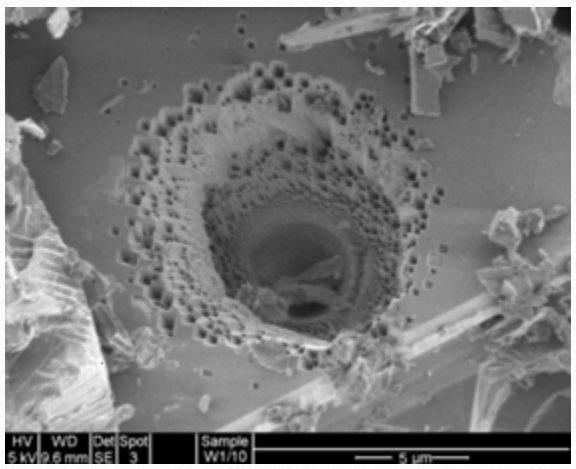


FIGURE 4 *e. SEM Image of the unusual surface features of Wombeyan calcite.*

previously been proven to respond differently to circulation compared to the rest of the cave, to have such elevated pCO_2 (Figures 1a-c). Preferably, measurements should be taken at several locations through the system, especially those areas in which there is high tourist activity, during intensive periods of visitation.

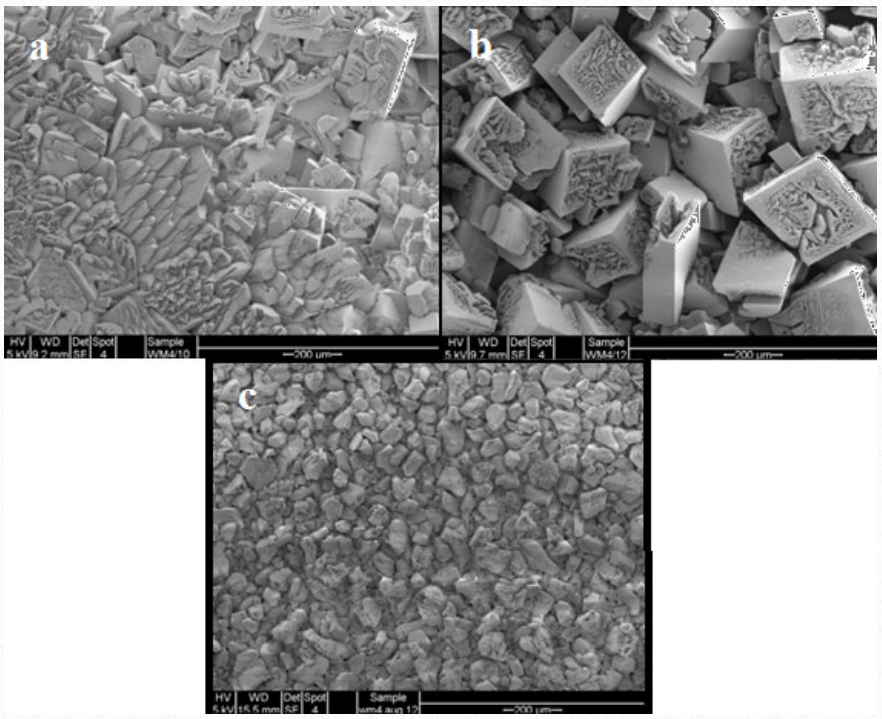
Results of Calcite Analysis

Multiple experiments were undertaken to discern the major impacts on calcite developing in the Wombeyan Karst. However, I will only discuss the results of the Scanning Electron Microscope (SEM). Past research has shown that by observing the shape of the calcite crystals clues of the depositional environment can be explained (Frisia *et al*., 2000). Crystals with a well formed structure can be indicative of a more stable environment with a slower drip rate and lower oxygen levels. However, crystals with an erratic shape are indicative of a highly active environment with a regular influx of fresh oxygenated air (Frisia *et al*., 2000).

Wollondilly Cave

Three sites were studied in Wollondilly cave (W1, W2, WM4) are all located within 2-5m of each other in the Mulwaree Extension and this provides an ideal circumstance in which to study calcite crystal morphology and clarify reasons for differences between the drips. According to theory of crystal growth, the rhombohedra form observed in this precipitate crystal experiment are consistent with a relatively low supersaturation and/or low presence of inhibitors (Frisia *et al*., 2000).

Figures 4a-e indicate a relatively constant balance between degassing and drip rate in modulating calcite growth in all W1 samples from 2009-2012 (Figures 4a-d). Noticeable in all samples from W1 are circular holes (Figure 4e), which are a constant feature of the Wombeyan Karst. A possible explanation for these abnormalities is that organic colloidal matter has disturbed the crystal growth. The outside of the crystal has continued growing by screw dislocation which is highlighted by this feature while this impurity has inhibited growth on the inside of the crystal (Frisia pers. comm., 2012). This may have implications for the distribution of trace elements within the calcite if selected species are incorporated within the colloidal material. Another possible explanation by Aquilano *et al*. (2003) describes the development of screw

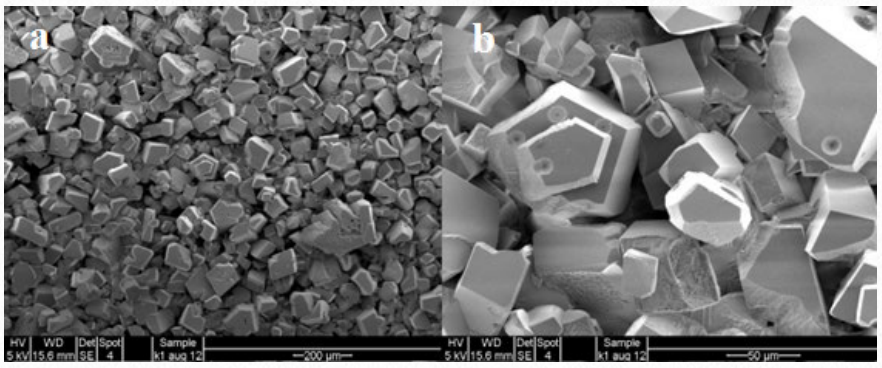


FIGURES 6 *a-c. SEM Images of Calcite samples collected from site WM4 between 2009 and 2012.*

dislocation growth around the surface of a gas bubble forming spherical cavities in the surface of the calcite crystal, and eventual encompassing of cavities within the crystal. More research is needed to clarify the cause of anomalies such as these and the samples at Wombeyan are ideal to try and solve the problem.

Samples from W2 show a variation in the concentration and average size of the crystals. When there are more crystals of a smaller size it can be inferred that an increase in supersaturation will lead to an increase in nucleation of crystal structures (Frisia *pers. comm*., 2012). Thus, when comparing the W2 samples from 2009 (Figure 5a) to the samples collected in 2012 (Figure 5c) there has been a decrease in supersaturation based on crystal size and number. The drip water samples for 2012 collected at this site showed depletion in calcium concentration, thus supporting the theory of decreasing supersaturation.

The crystals of drip WM4 (figures 6a-c) are very distinct due to unusual features on the faces of the calcite. WM4 has a rapid drip rate and the defected surfaces may potentially be the result of not being fully immersed in the supersaturated film fluid preventing the crystals from growing with flat surfaces. The presence of incipient dendritic structure points to instability at the crystal/liquid interface (Frisia *et al*., 2000). Having no data on the flushing of organics at the drip site, I can only speculate that both the supersaturation and the presence of impurities are higher here than in the other two drip sites.



FIGURES 7 *a-b. SEM Images of Calcite samples collected from site K1.*

Kooringa Cave

Two sites were studied in Kooringa, however, only K1 precipitated sufficient calcite for analysis (Figures 7a-b). Rounded crystal faces indicate that the film fluid is out of equilibrium due to an increase in supersaturation or, potentially high levels of organic molecules or high Mg concentrations restricting growth (Frisia, 2012).The most significant finding of the SEM work was that calcite developed in Kooringa Cave also displays the same holes that are common throughout Wollondilly and should be a focus of future research.

Conclusions

To conclude the complex nature of Wollondilly Cave greatly restricts the natural breathing of the system in contrast to Kooringa Cave which was found to concur with past research and increase in levels with increasing distance from the entrances.

Despite CO_2 spatial variability due to the cave architecture, there is a distinct seasonality in CO_2 levels in both caves at Wombeyan which indicates that the speleothems may record a seasonal signal instead of annual climate characteristics.

The natural levels of CO_2 in both caves were not found to impact or inhibit developing calcite, however, anthropogenic inputs greatly increased the CO_{2cave} implying that levels may approach the limestone threshold in areas of higher tourist traffic.

Calcite collected from sites in the same cave atmospheric conditions were shown to reflect variances in drip rate, flow patterns, supersaturation and film fluid thickness.

Overall, this project is good starting point for more intensive future studies. The field component of the project (7 months) was insufficient to gain a robust understanding of seasonal cave CO_2 variability. By contrast, the benchmark study at Grotta di Ernesto (Frisia *et al*., 2011) required a decadal monitoring program.

Funding proved a constraint on the number and type of surveys that could be undertaken. Still, this pilot project shows the potential of monitoring as a tool to understand speleothem proxies. This study has highlighted the need for more monitoring and shown that speleothem proxies from the Wombeyan karst can be better understood in terms of seasonality if future research is carried out.

Future research would have to be carried out regularly over at least 2 years and would require access to more CO_2 monitoring equipment, funding and interdisciplinary collaboration, in order to gain a greater perspective on the seasonal nature of CO_2 concentration variability.

Acknowledgements

Very special thanks go to my supervisors Janece McDonald and Silvia Frisia. Thanks also go to the School of Environmental and Life Sciences and Anthony Kiem for their financial contribution, the National Parks and Wildlife Services for providing access to the Wombeyan Caves and accommodation and to the Wombeyan Caves Staff. I'd also like to thank Lawrie Henderson for his cartography skills, the ANSTO Environmental Lab for assistance with the trace analyses, David Phelan for help with the SEM and Nellie Hobley for help with the stable isotope analyses.

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Flank margin caves on a passive continental margin: Naracoorte and other southern Australian examples.

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[2]Victorian Speleological Association Inc

Abstract

Flank margin caves (FMC) have been described specifically from the Bahamas and the islands of the north Pacific such as the Marianas. In the former case the relationship of the freshwater lens and the caves is clearly related to the fluctuations of sea level over the past ~20,000 years on a relatively tectonically stable basement. In the Marianas the relative sea level has dropped and there are a series of caves now well above the active cave forming level. FMC are typically described from relatively young, highly porous and permeable limestones, usually aeolianites.

Australia has a significant amount of aeolianites and other highly porous and permeable marine calcarenites. There is a lot of evidence that caves have formed in previous coastal locations in such host rocks. However the passive passive continental margin tectonic conditions of southern Australia are significantly different from either the Bahamas or the islands of the north Pacific.

This paper will discuss the speleogenesis and characteristics of caves forming in this context. The areas discussed will include the Nullarbor, Naracoorte, Glenelg River and Rottnest Island.

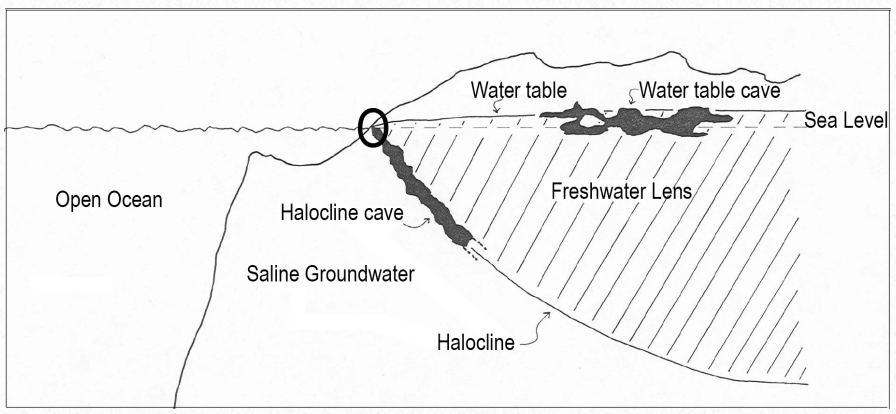

FIGURE 1. *Superposition of the vadose/phreatic and fresh/marine mixing zones at the lens margin means cave development is favored at the lens margin, under the flank of the land; hence the name "Flank Margin Cave". (After Mylroie and Carew)*

The Characteristics of Flank Margin Caves

Flank Margin Caves form along the margins of the freshwater lenses just beneath the flanks of the enclosing land mass (Mylroie and Carew 1995, Mylroie *et al*. 2004) (Figure 1). This is where aggressive solution occurs as the result of mixing corrosion (Bogli 1980) and either the saline halocline or the meteoric water/water table. They have predominantly been described in island environments, partly because island fresh water lenses are more intensively studied that the equivalent on continental margins. The cave development is primarily related to the geometry of the freshwater lens.

These caves have a distinctive passage shape and configuration due to their development as isolated entrance-less chambers (or groups of chambers) often described as "beads on a string" (Mylroie *et al*. 2001). These chambers are breached as surface erosion occurs. The complex cave perimeters show dissolutional wall morphologies such as bell holes and very large scallops. As the chambers were sealed and with ~100% humidity, dense crystalline calcite spelothems are common. Solution has cut across carbonate facies disregarding differences in porosity and grain size and primary structures such as bedding planes.

Southern Australian coastal karst

Across southern Australia highly porous and permeable carbonates occur in a coastal setting. These carbonates are either Oligocene to Pliocene cool water marine limestones or Pleistocene aeolian calcarenites derived from them (Figure 2).

The tectonic setting is a passive continental margin, which has been developing since the Late Mesozoic when the break up of the Gondwanan super continent occurred. The active spreading centre, the Southeast Indian Ridge, separates the Antarctic Plate from the Australian Plate and is some 2500 - 3000 km to the south. The structure of southern Australian continent is largely inherited from the pre-existing Cretaceous extensional faulting.

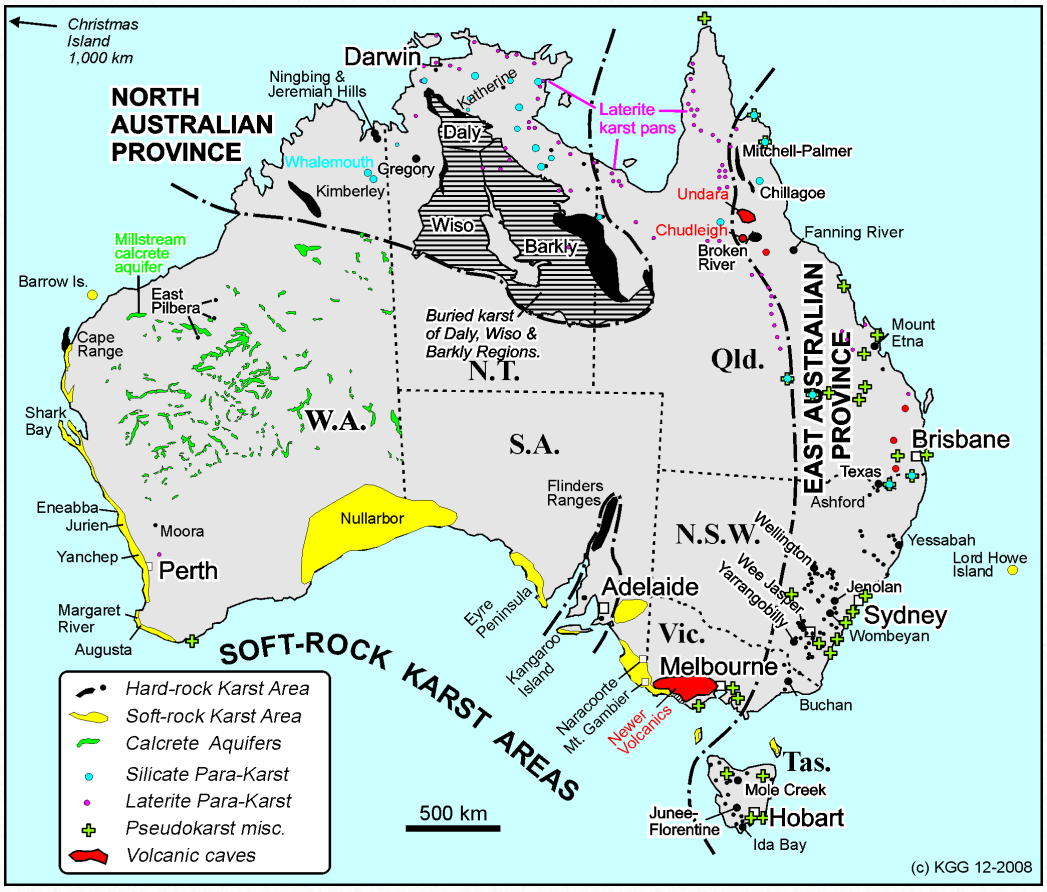

FIGURE 2. *Australian Karst areas (after K.G. Grimes). Soft Rock karst areas are the Cainozoic marine cool water carbonates and the aeolianite strand line dunes.*

The Australian continent is generally considered a 'stable' intra-plate region despite having high levels of seismicity (Blewett *et al* 2012). Its passive margin, where the transition from oceanic to continental crust occurs, exists along the south coast. However the plate is moving generally northwards at a rate of ~7cm pa; the fastest moving plate on Earth.

Australia also has significant neotectonic activity especially across the southern coastal area. There are kink folds in ~125 ka old cemented aeolianite at Cape Liptrap (Sandiford, 2003). The Eucla Basin has been tilted, expressed as a west-side up, east-side down tilting of ~100–200 m during the Neogene; a broader north-down southwest-up dynamic topographic tilting of the Australian continent associated with relatively fast (6–7 cm/yr) northward plate motion since fast spreading commenced in the Southern Ocean at ~43 Ma (Hou *et al* 2008). Similarly there is significant uplift across southeast Australia where a significant Late Miocene uplift caused a regional angular unconformity, at around the Miocene-Pliocene boundary onshore (Dickinson *et al* 2002, Dickinson *et al* 2001). This event occurred across and coincided with a change in the dynamics of the Australian plate to the current compressional regime. A second, but less significant, uplift occurred in the Late Pliocene to Early Pleistocene (Dickinson *et al* 2002, Dickinson *et al* 2001, Paine *et al* 2004). During the Pleistocene, as the sea regressed, bioclastic carbonate beach, barrier and sub-parallel calcareous and karstic dune complexes (Bridgewater Formation eolianites) were deposited over extensive areas of the western Otway Basin in a high-energy coastal environment with barrier dunes and associated lagoons (Figure 3). Dune building occurred from at least 1.3 Ma through to present times, and continues today on the coast where suitable conditions of sediment supply are available. The gradual uplift of the coastal plain (~0.07 mm/year) west and south of the Kanawinka Fault resulted in a well dated, punctuated, time-transgressive aeolianite sequence associated with sea-level high stands spanning most of the Pleistocene (Belperio *et al* 1995). Uplift is a factor in the preservation of these dunes and their karst.

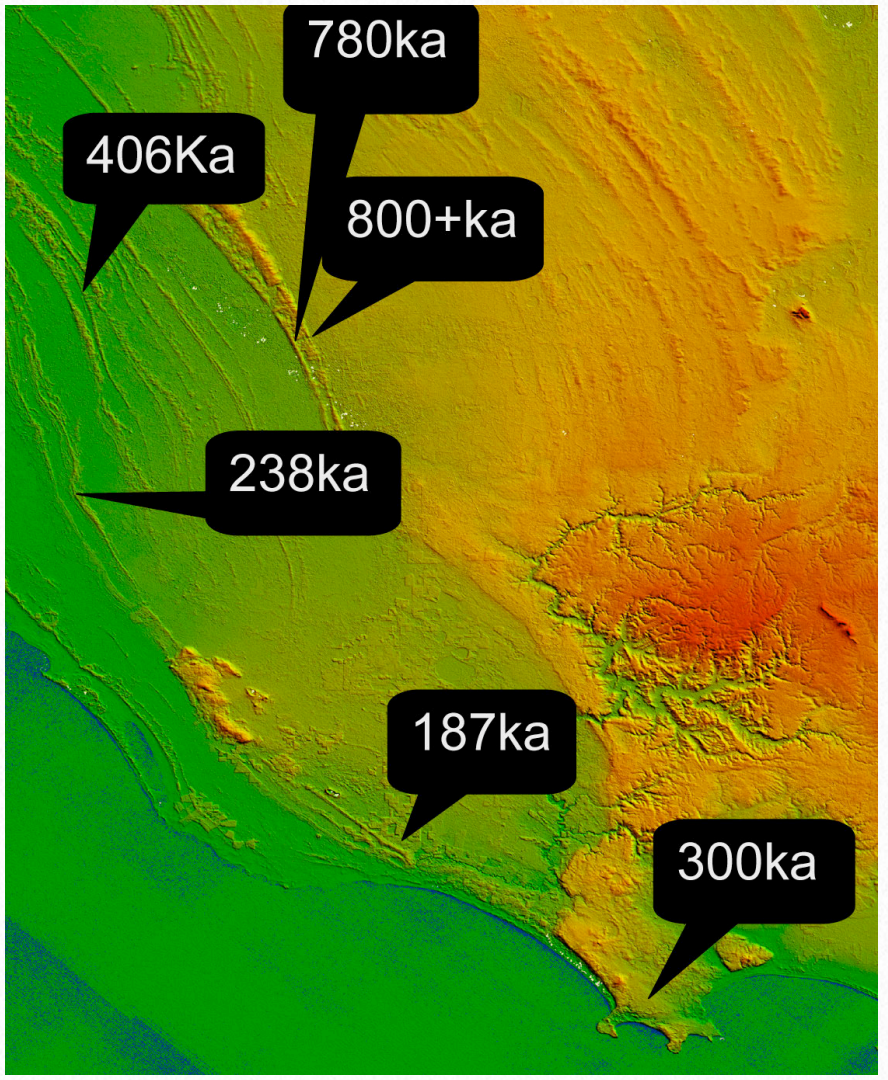

FIGURE 3. *Dated dunes. Dunes dates do not include confidence levels. Dates are thermoluminencense dates from a number of published sources (Belperio, 1995 & White, 2000)*

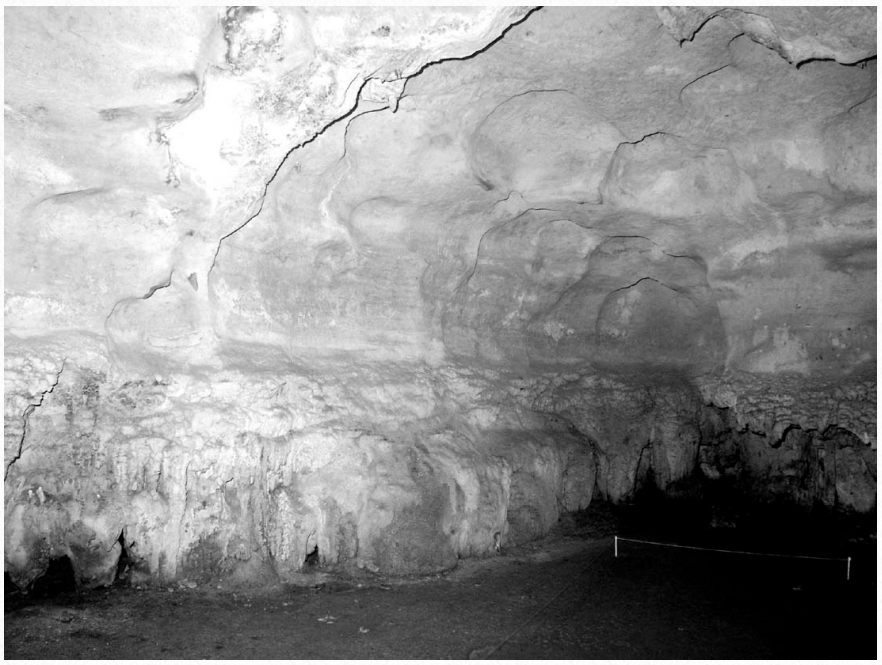

FIGURE 4. *Large scallops (S) on the wall of Wet Cave, Naracoorte. These are high up on the walls and are not obscured by collapse. Some are over a metre in length indicating very slow, almost stagnant water.*

Charactersitics of the karst

Distinctive characteristics of the karst on calcareous dunes include a range of features that are distinctively associated with Flank Margin Caves. These include shallow caprock caves, irregular horizontal mazes, caves that are either dominated by collapse domes or "inclined fissures", with little or none of the original solutional passage remaining. Many of these features are also found in the caves in the poorly consolidated marine cool water carbonates, although these have a stronger linear orientation in the larger caves. The caves in both lithologies have been modified by extensive collapse, solution pipes, bell hole development and speleothem deposition, especially moonmilk, can be extensive.

Wall morphologies indicate phreatic dissolution without turbulent (conduit) flow as is typical for FMC conditions. Four main solutional features found are horizontal grooves (notches), speleogens, spongework and large non-directional scallops (Figure 4). In addition, ceilings with avens and bell holes are found in many caves.

Bell holes or ceiling pockets are cylindrical cavities with vertical long axes, varying between 0.3 to 1 m in diameter and 0.5 to 1.0 m deep, tapering upwards and are present in the ceilings of many caves. These have not been extensively reported in the literature in temperate climates but are common in the poorly consolidated limestones in southern Australia indicating that they are not necessarily restricted to tropical and sub-

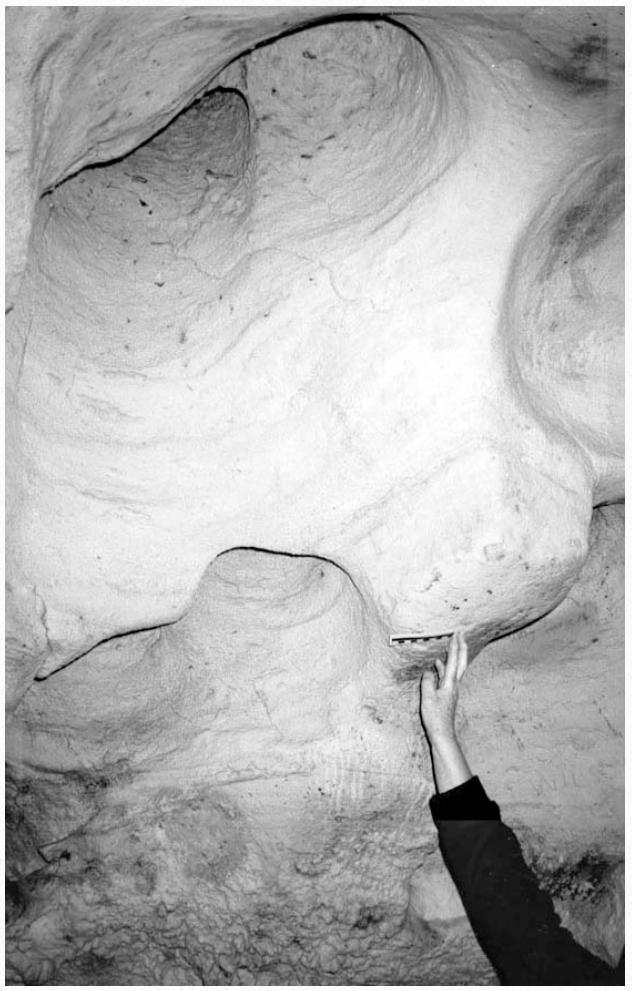

FIGURE 5. *Bell holes and speleogens Wet Cave (U10) Naracoorte Photo N. White*

tropical climates. The most spectacular are in the roof of Wet Cave (U 10), where over 50 densely spaced, narrow vertical cones of up to I m depth and 0.5 to 0.8m diameter are found (Figure 5). As a feature of ceilings rather than walls, and not associated with jointing in the cave ceilings, bell holes show that these large chambers were primarily formed by solution, and these chambers generally lack collapse debris.

Speleogenesis

Karst phreatic caves formed in coastal environments on an upwarping continental margin, where specific localised conditions created enhanced solutional conditions over relatively short time periods. Subsequent modification of the karst was controlled by the combination of continuing neotectonic uplift combined with falling sea levels throughout the rest of the Pleistocene. The position of the dated dunes in the western Otway Basin e.g. Naracoorte, mean that we have a well documented sequence of host rocks over the past ~1M years.

When deposition of the East Naracoorte Range occurred in the Early Pleistocene, the coastline lay approximately along the Kanawinka Fault, about 70m above present sea level (Figure 6). Thus cave development was probably influenced by

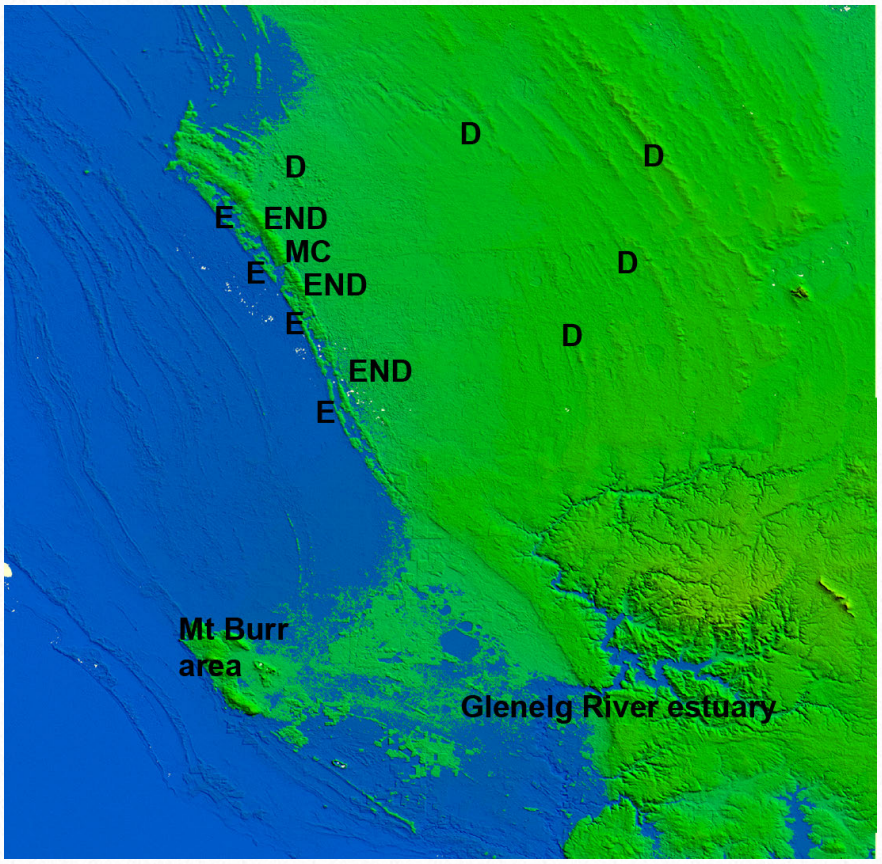

FIGURE 6. *Relative Sealevel at 70 higher ASL than present showing the coastal and estuarine conditions of the Naracoorte area.*
E = estuarine areas,
D = Dunes (mostly older than the East Naracoorte Dune),
MC = Mosquito Creek,
END = East Naracoorte Dune.

the halocline mixing zone at the base of the fresh water lens, enhancing aggressiveness. The groundwater mixing zone geometry is controlled by sea level and the water table in high permeability limestones such as the Miocene cool water Gambier Limestone. Additionally the watertable would have been generally very flat at Naracoorte. The caves show many characteristic features of FMC. The main area of cave development lay probably between 400 m to 500 m inland from the high water mark when sea level was at 70 m above present conditions. If the water table were between 1 and 2 m above sea level in this area (assuming a similar very low gradient of 1:250 to that inland from the present coastline), the fresh/seawater zone would have been at least 40 m below sealevel. This appears to be below the depth at which most caves at Naracoorte have developed (~61 m ASL and 25 to 30 m below present surface). However, if the area was an estuarine or back swamp environment similar to the present coastal areas, e.g. Glenelg River estuary, the water table would have been lower, e.g. at 0.75 m above sea level or less. The halocline would then be at ~30 m depth and halocline enhanced formation is possible.

Similar development and features can be seen on the Nullarbor (Burnett *et al* in review), and on both Rottnest and Kangaroo islands (Mylroie and Mylroie 2009). However in all cases the length of time of the landscape development means that significant landscape lowering has occurred and the caves may now be closer to the present land surface than when they formed.

In the case of Kangaroo Island, Mylroie and Mylroie (2009) have argued for the presence of FMC but have over emphasised the role of the Pleistocene eustatic sea level fluctuations and under estimated the role of neotectonics which has overprinted the global sea level fluctuations on the southern Australian continental margin.

Conclusions

Limestone dissolution is enhanced at the vadose/phreatic and fresh-water/saltwater interfaces due to mixing effects and oxidation of organic matter at these density interfaces. The position of the fresh-water lens has fluctuated through a vertical range of over 100 m, due to Quaternary glacio-eustasy, but local tectonics can overprint glacio-eustatic events, adding to the complexity of the record. The karst is eogenetic, having been formed in eogenetic rocks, which are rocks that never underwent burial beyond the range of meteoric diagenesis.

The karst landscape development on the Cenozoic cool water marine limestones and eolianites along the southern Australian margin are related to the coastal conditions when the main karstification has occurred. This much more extensive than previously thought and helps explain the complex speleogenesis. The uplift of the land coupled with the fluctuating Pleistocene sea levels has resulted in a much more complex scenario than previously thought and explains the relatively sparse karst areas interspersed with very intense karstification.

Acknowledgements

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Origins of Cave and Feature Names in the Jenolan Show Caves

Kath Bellamy and Craig Barnes

Abstract

As guides strove to acquaint visitors with the “exotic” cave environment, a tradition of giving features familiar names was established, and continues to the present day. It links us with the discoverers and early visitors. To the informed, names of caves and formations can take on a hieroglyphic character that can guide you through the history of the cave. Being aware of the feature names can give a glimpse of the discoverers, prompt interest in the adventures of early visitors and even recognise the work involved in making the caves accessible.

Introduction

In 2005, as part of the Survey Project, the authors started to work on names for the maps that were being produced. The *Jenolan Show Caves* are made up of “caves”, sections of a system that have been given specific names to facilitate them as cave tours (Figure 1). The naming project immediately expanded as some cave and feature names provided an historical and cultural record of the *Jenolan Show Caves*. The sources for this work were guidebooks, newspapers, tourist publications, postcards, and photographs. Valuable contributions also came from the oral history supplied by past and current guiding staff. The result is an important record of the tradition of naming at Jenolan from the discovery of the caves to the present.

History

The cave system itself was known by various names: *McKeon’s Caves* (1856), *Binda Caves* (1867), *Fish River Caves* (1879) and finally on 19th August 1884 the name *Jenolan* was approved (Havard 1933). The first recorded descriptive names commenced with the discovery of the arches in 1838 (Ralston 1989). Samuel Cook (1889) suggested that an arch was named the *Devils Coach House* for reasons similar to those that created the nomenclature for the numerous Devils Pinches and Peaks for surface features around the world (Figure 2). Captain Cook gave the name Devils Basin to a har-

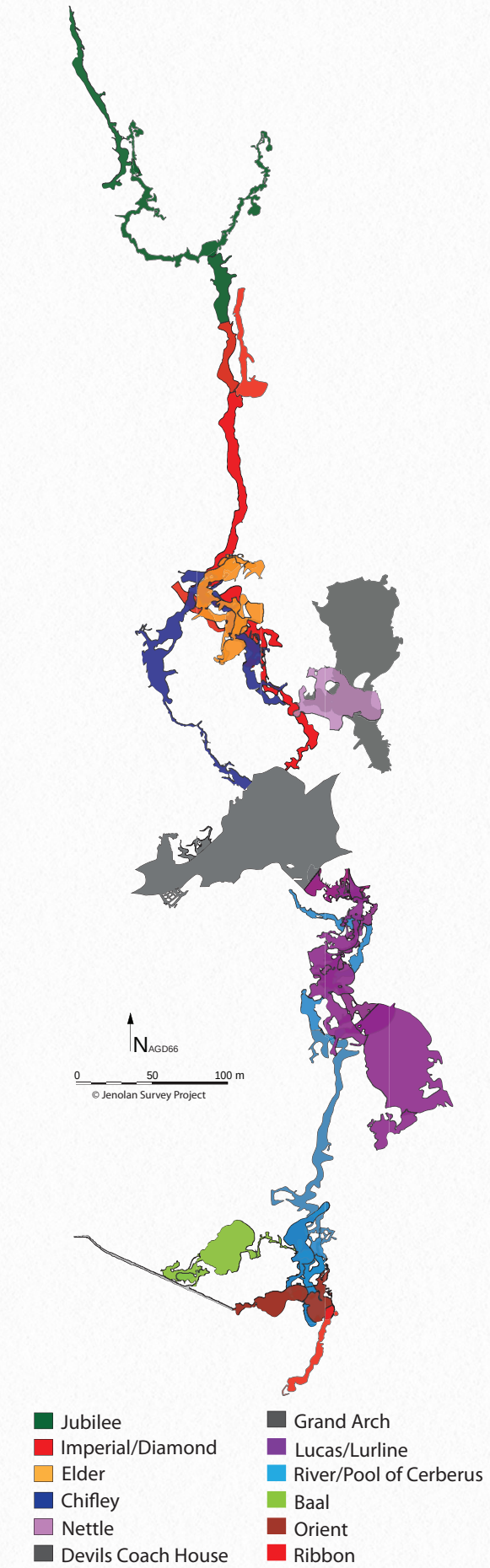

FIGURE 1. *Overall map of the Jenolan Show Caves*

FIGURE 2. *Devils Coach House.*

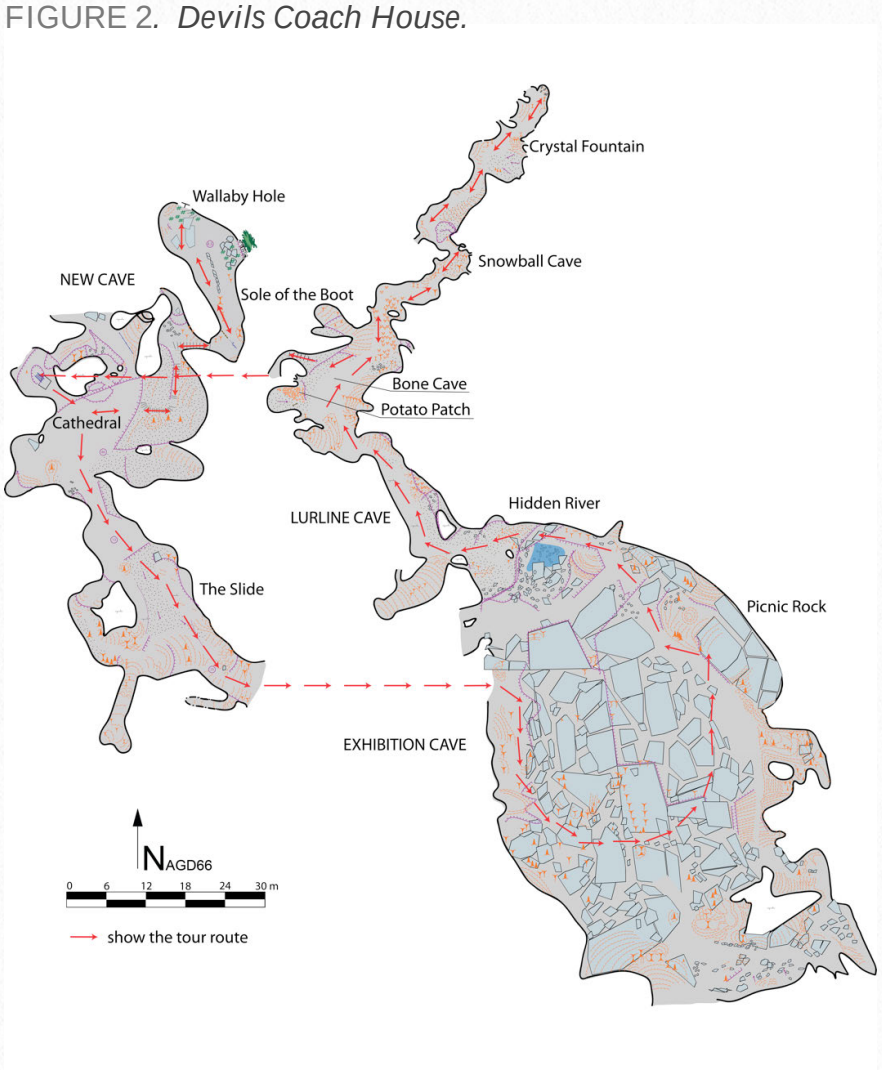

FIGURE 3. *The New Cave tour.*

bour because of its gloomy appearance, being surrounded by savage rocks. For a brief period, the *Devils Coach House* was renamed *Easter Cave*, although the name never became popular.

By the 1860's names had been established for the *New Cave* (Ralston 1989). Visitors began their tour to this cave (Figure 3) by hiking through the bush to *Wallaby Hole*, entering the cave through the *Sole of the Boot* to reach the *Cathedral*. They had to negotiate *The Slide* by sitting on a bag and descending further into the cave. In the *Exhibition Cave* they climbed over rocks, lunched on *Picnic Rock* and drank water from the *Hidden River*. In *Lurline Cave* those familiar with William Wallace's opera Lurline, first performed in 1860, could see "...the coral bowers and cells to which Rudolph was transported" (Cook 1889). In an area of *Bone Cave* called *Irish Corner*, there was an interesting formation known as the *Potato Patch*, and further along *Bone Cave* were *Snowball Cave* and *Crystal Fountain*. Returning to *Irish Corner*, visitors were astonished to find they had to ascend a wire ladder to return to Cathedral and thence the cave entrance. Although this route is not used today, many of these names are still in use in the Lucas tours.

Some names became enshrined with the advent of guidebooks; "English visitors see in this stalagmite the features of Lord Salisbury" (Trickett 1905). According to the 1924 *Orient* guidebook, visitors "...one and all will recognise uncanny imitations..." and decorations seem "...veiled in a film of suggestion where more is meant than meets the eye and depends to a certain extent upon the imagination" (Havard 1924). At present the *Orient* contains 134 named features, by far the most of any cave at Jenolan (Figure 4). Many of the features have been renamed over time, with some features like the *Dome of St Pauls* renamed as many as 5 times (so far), to give a total of 206 names for the *Orient* alone. There are only 119 of the 206 names on the figure; it was not possible to fit any more on!

The reasons for names and name changes for caves, parts of caves and features are multitude, and the following outlines just a few examples.

The imagination of guides and tourists

From the very beginning, cave guides and tourists used names to describe formations, in part to make the strange

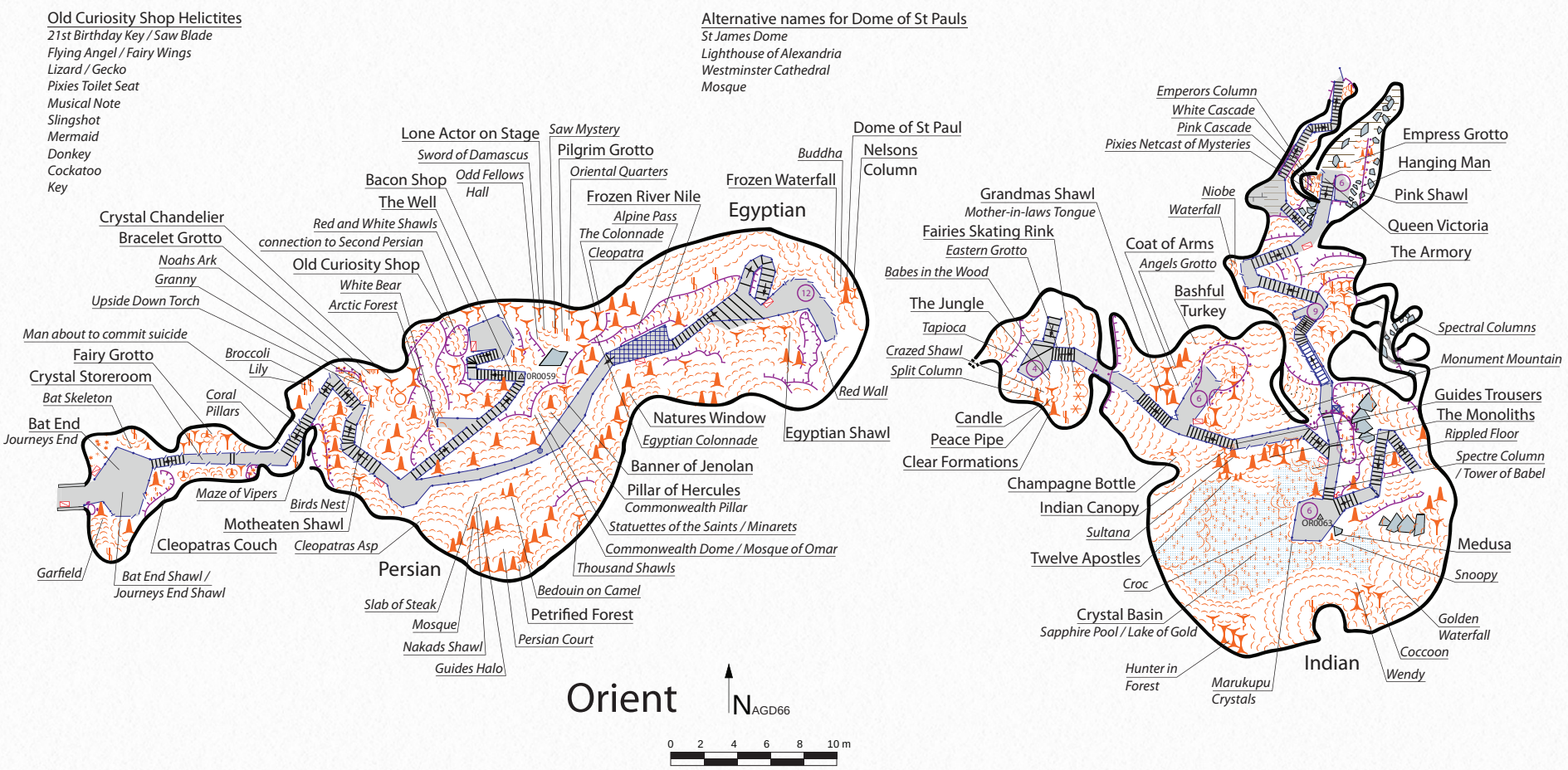

FIGURE 4. *Map of Orient.*

FIGURE 5. *The Minaret.*

more familiar. It is a tradition that has continued and evolved. For example, renamed by young visitors, the *Unicorns Horn* has become *ET's Finger* and *The Minaret* has become *Ice Cream Cone* (Figure 5). The things that prompt a person to choose names are usually explained by culture, history and, sometimes, even profession. For example, a medical person is probably responsible for describing the helictites in the *Dragon's Throat* as *Diphtheria Symptoms*.

The beautiful and small

There are many sparkling calcite crystal decorations at Jenolan, such as stalactites, stalagmites, flowstones and helictites, that have been named but some of the most intriguing formations are obscure. Old publications and photographs have en-

FIGURE 6. *Old Curiosity Shop – there are 13 helictites named here (see Figure 4).*

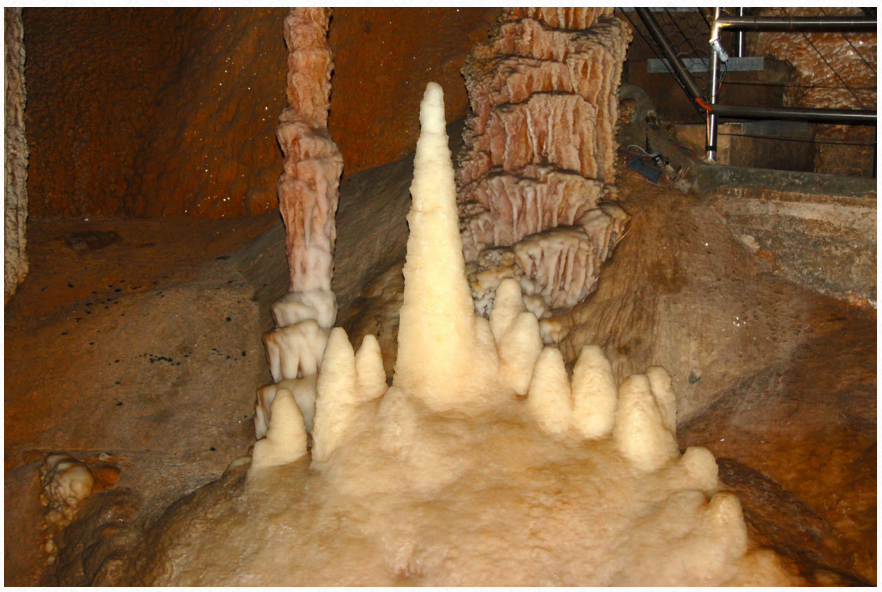

FIGURE 7. *Twelve Apostles.*

abled identification of these treasures. Among one mass of tangled helictites, named *The Battlefield*, is the minute *Leaping Stag*. Along with the *Staghorns* in Jubilee and *The Diminutive Horse Head* in Chifley, these represent some of the smallest examples of named features at Jenolan.

Ambience of the environment

George Rawson (1883) wrote of a visit to *Fish River Caves* that "...one is bought into a silent and reverent attitude...", hence it is no surprise that many names of religious significance were used. There is an *Organ Loft* and *Pulpit* in the Grand Archway, a *Sanctuary* in Nettle, a *Cathedral* and *Bishop* in Lucas, *Twelve Apostles* in Orient (Figure 7), with Imperial and Chifley both having a *Vestry*. Biblical names include *Elijah's Retreat*, *Tower of Babel* and *Lots Wife*.

FIGURE 8. *Pink and White Terraces.*

FIGURE 9. *Long Tom.*

Historical events

Historical events have also played a part, particularly in renaming features. *The Terraces* in Exhibition Chamber became the *Pink and White Terraces* (Figure 8) in remembrance of those in New Zealand destroyed by the 1886 eruption of Mount Tarawera (Cook 1889).

Mafeking was besieged during the Boer War for 217 days, from October 1899 to May 1900. The relief of Mafeking by the British from the Boer coincided with the discovery of a high level passage in the *Exhibition Chamber*, hence its name and the names of some features in it (Figure 9).

Currently, there is a proposal to commemorate the Queen Elizabeth II Jubilee with a named dome and arch in Jubilee and Imperial respectively.

Honouring Australian dignitaries

In 1878 the *New Cave* was named *Lucas* after John Lucas, M.L.A; "In consequence of the great interest I displayed, and by the publication of my paper, which first drew the attention of the public to them, the Surveyor-General and other high officials made an official visit, and named the largest cavern The Lucas Cave" (Rawlinson 1976). One formation was named *Judge Windeyer's Couch* "...because it is said that the learned judge sat on it when he visited the caves" (Cook

FIGURE 10. *Plaque commemorating the naming of Chifley Cave.*

1889). In 1952, the *Left Branch* of *Imperial* was renamed *Chifley Cave* in honour of J.B. (Ben) Chifley (Figure 10), who represented in the Federal Parliament the region that included Jenolan. The name change attracted some criticism; "The gesture, however well intentioned, will not give much pleasure to Mr. Chifley's admirers ..... for the sake of the memory of a highly regarded man, I hope some more tactful Chief Secretary changes the ludicrous name of Chifley Cave back to what it was before" (Sunday Herald 1952).

After Ladies

In Lucas, *Queen Victoria* is unmistakable as she looks out over the *Royal Chamber* (Figure 11). Other ladies also featured throughout Jenolan, with *Lady Cecilia Carrington*, *Queen Esther* and *Margarita Cracknell* having chambers, as do *Selina* and *Lucinda*. *Katie* and *Edie* have their bowers and *Matilda* has a retreat, while *Josephine*, *Nellie*, *Ethel* and *Min-*

FIGURE 11. *Queen Victoria.*

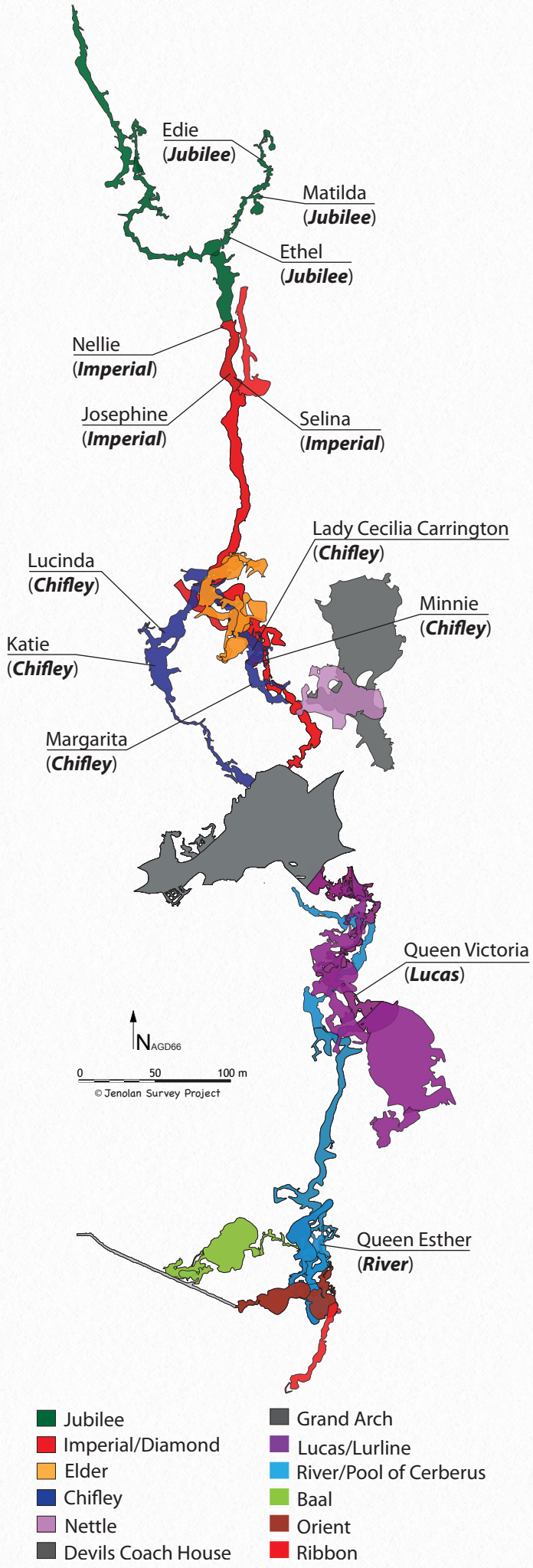

FIGURE 12. *Features named after the ladies.*

nie merited grottos (Figure 12).

Cave incidents

Jeremiah Wilson, exploring *Jubilee* in 1893, described the dreadful experience of having his candle go out and believing he had no matches. Fortunately he found some in his pocket, but he ensured the event was not forgotten by naming the place where he was at the time *Wilson's Despair*. In *Imperial*, *Ridley's Short Cut* was named after a "...a visitor who stepped back to allow a lady to pass and fell through (to a cave below)..." (Leeder 1994). The guides describe the incident as a "...rambling visitor who strayed from the fold, put a foot in the wrong place, and descended fifty five feet without the benefit of the rope. He landed on a coil of netting and bounced off" (Ralston 1989).

The influence of lighting

Different lighting can influence what can be recognised in the caves. Scenes lit by flickering candles, and at times augmented by magnesium lamps, delighted early visitors. However, the *Stooping Lady* could "...be seen only by candle light, the magnesium flare being too penetrating for this particular effect" (Foster 1890). *Harry Potter's Scar* was visible in the *Exhibition Chamber* until the lighting system was recently upgraded. The new lighting did however result in a perfect representation of a *Terra Cotta Warrior* appearing in shadow on the wall over the *River Styx* in River cave.

Man-made objects

There is an iron *Jacobs Ladder* in River while a previous wire *Jacobs Ladder* was used for the descent to the Imperial River prior to the concrete stairs being completed in September 1900. Near the *Pool of Reflections* a memorial block to *Bertha*, a cement mixer buried beneath it, commemorates the hard work involved in constructing paths in the caves. The proposed *Trickett's Tunnel* was eventually named the *Binoomea Cut* when it was completed in 1954 (Figure 13).

In this discussion the evolution of names in the *Jenolan Show Caves* has been illustrated with selected examples; the Excel spreadsheets for the Survey now contain more than a thousand names. The *Jenolan Show Caves* can be thought of as the "Caves of a Thousand Names".

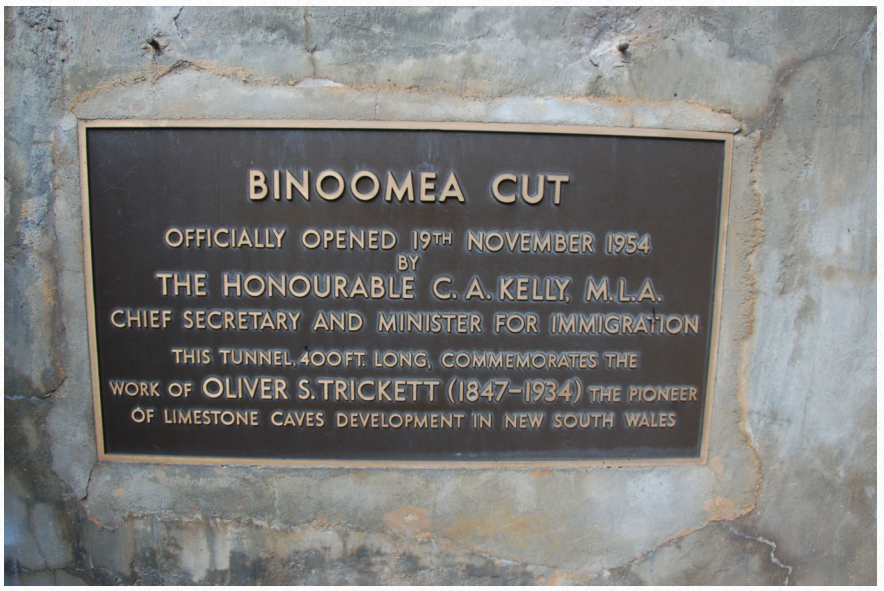

FIGURE 13. *Plaque commemorating the opening of Binoomea Cut.*

Acknowledgements

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Video

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Core sampling in Western Sumatra, Indonesia

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Abstract

Researchers from The Australian National University, Canberra in collaboration with the Indonesian Institute of Sciences, are conducting a series of climatic studies of the South East Asian monsoonal margin. The focus is to collect core samples from coral reefs (Sunda Strait) and stalagmites (Western Sumatra). I was appointed the research party's caving consultant. This paper is a brief outline of the caves we visited in June-July 2012 and our activities. At the stage of writing, the palaeoclimatic data are still pending.

Introduction

From the outset I wish to state that I am not a climate researcher and know little of the technology that is involved in analysing stalagmite core samples and palaeoclimate. The Indonesian archipelago and to some extent northern Australia is on the South East Asian monsoonal 'edge'. This expedition was an initial investigation to find suitable sites for palaeoclimate sampling to determine if the Toba super-eruption (a massive volcanic eruption in Sumatra between 67,00 & 75,000 yrs ago) had climatic effects which may have influenced early human dispersal in Australasia, and to investigate Indian Ocean Dipole rainfall extremes in southern Australasia.

We understand that caves are a true window into the past and that their development and secondary deposition is greatly influenced by weather conditions on the surface. Climate changes over thousands of years are expected to show in the secondary deposition record of stalagmites. Stalagmites formed well inside a cave, far from any entrance effects, and in upper chambers away from stream way effects, are of great value in such studies.

Planning

I was approached by the Australian National University (A.N.U.) to join a research group who were planning to spend 5 weeks in Indonesia in conjunction with LIPI (The Indonesian Institute of Sciences) to collect core samples of coral and stalagmites for future climatic studies. Planning pre-trip was difficult, with limited information on Sumatran caves, limited information on the group's caving abilities and a brief list of caving gear left over from previous cave research groups sitting in Bandung, about 3 hours drive from Jakarta.

FIGURE 1 *The Golden Stairway, Banta cave, Western Sumatra*

Cave reports were available from Covington from an American Expedition in 2000 (Covington, 2000), and several French expeditions (Caving Association of Pyrenean, 1995, 2000, 2003, 2005), plus basic cave statistics from Dunbar (Dunbar, 2004). The French report resulted in some confusing translation after running through a Google translation program! These reports were more a story of the groups' exploration and although they gave some details of what each cave involved, they gave no indication of stalagmite occurrence and scant details on upper passages and chambers that might contain suitable sampling sites.

It was decided to avoid any challenging vertical caves and to target caves that seemed to have some length and 'sounded' like they may have upper sections.

One major challenge needed to be overcome just one-week before I left Australia: I received an email from Indonesia stating that all the batteries sitting in Bandung were faulty. Urgent emails went out to anybody I knew in Australia who used the same system, but fortunately Garry Smith came to the rescue and managed to secure an adequate quantity of batteries for me, just in time.

Jakarta

My time with the group was 3 weeks, some of which was to be spent in Jakarta obtaining the necessary permits. I needed to obtain a research permit, an extended visa called a "kitas", a police travel permit, a letter from the Indonesian Home Office to be shown to local authorities and a Police Identification to also be shown when demanded.

I was supposed to be met in Jakarta by a local who would assist me in getting around the various government departments (my Bahasa is non-existent), however the local contact failed to appear. So armed with the address of the research permit place RISTEK (The Ministry of Research and Technology), I grabbed a taxi and commenced my quest. In brief, it wasn't a brief process, and the permits I did obtain took 4 days, with others that "may take another week", so after I had obtained the most important documents, it was decided that we really needed to head up to Western Sumatra and do some work. Incidentally, the Indonesians that I was working with were amazed that I got through the permit process all by myself; I found the best approach is to ask lots of questions and find someone who wants to practice their English: Indonesians are extremely friendly and willing to assist. A quick trip out to Bandung with one of the A.N.U. researchers sorted out what gear we thought we might need to be driven for 3 days to the area of caves we had targeted. We Australians (2 A.N.U.researchers and myself) took the easy option and flew up to Padang, to be met by our local contact from a university there who was to coordinate with any locals.

FIGURE 2 *Core sampling*

The caves we targeted

Payakumbuh town: Peyangang Cave. This is a bird's nest collector site (for bird's nest soup from swiftlet nests). Locals and government officials are very protective of such sites, as the collecting of bird nests is very lucrative. On our first trip we went 350m in, encountering considerable mud and slippery surfaces; several rock falls to climb over, with only 2 samples taken from a high ledge involving a tape climb.

On the following day we went about 2km in, but found very few stalagmites with only 2 more samples.

We next went to Banta cave which was a 30 minute walk through the jungle and turned out to be an impressive entrance chamber that was quite photogenic, with a lower level involving a difficult climb down. We managed to obtain a few good stalagmites for samples, this time well away from the entrance. We discovered a long stalagmite that had fallen and broken- the locals were very keen to “reconstruct” this for a photo before removing it from the cave for future sampling. A further day in Banta Cave gave us what should be some excellent core samples.

Nearby was an active quarry that had revealed a small cave which was about to be destroyed by the quarrying operations, so we used the opportunity to remove several stalagmites that had originally been some distance from the surface. It seems sacrilegious to be ‘breaking” speleothems, but I had to remind myself that they were only going to be destroyed anyway!

After a rest day doing some sightseeing we headed for a cave called Ayr Lulus (which means escaping water) which was quite a long walk through the jungle, involving a difficult climb down, with a huge entrance chamber, but the cave closed down to a tight stream way soon afterwards. We only found stalagmites close to entrance, which generally is not a good sampling site as deposition is greatly influenced by entrance factors; however 2 core samples were taken, but likely to be poor.

We then moved about 3 hours south to a small town called Sisawah. Considerable negotiation with the local authorities occurred in Bahasa, with us nodding now and again. A home stay was arranged about 1km from town. Our hosts spoke no English, but seemed pleased to have us stay. There was no running water and electricity had only just been connected a short time earlier, so it was still a novelty, but appreciated for charging up batteries. Food was brought each morning and evening from the village downstream, no doubt using the same water that emerged from a nearby cave, that we washed in and for ablutions. I found it amazing that no one fell ill. Within one hundred metres of our living quarters was Mantu Cave, which we penetrated about 800m and obtained 5 mini-cores, and 1 stalagmite as sample. This cave is about 3.5km long.

The following day we climbed steeply up a hill adjacent to our house to Kompe Cave; it had four levels, with the bottom

FIGURE 3 *Hairy Mary (Thereupoda longicornis)*

needing SRT gear, some huge chambers with thousands of bats, a couple of snakes and some sort of insect that seemed to find their way into any orifice available, but unfortunately no stalagmites.

A two kilometre walk to the other side of the village took us to Ngalau Banta Bung cave, which has been used as a training cave by local caving clubs. This was another stream way, with some crawling, but the water temperature was quite pleasant. Fortunately this cave had a few upper levels so we managed to obtain 3 core samples.

That evening some of the locals arrived at our home stay and much heated discussion ensued. Apparently there had been some sort of misunderstanding about what we had been up to and one local landowner thought we were planning to destroy his cave. We ended up having several stalagmite samples confiscated and paying a small fine ($30) as compensation. It certainly pays to have a local liaison person who speaks Bahasa as we had no idea what was going on.

That ended our caving, so all that remained was to pack up all samples for shipping back to Australia and fly back to Jakarta.

At the stage of preparing this paper, our samples were still in Indonesia, no doubt tied up in Indonesian red tape, so no analysis of our samples has been possible.

Environmental issues

I found Indonesia attitudes to caves to be quite environmentally insensitive. Caves are seen as a resource for bird's nests, and this is regulated in an attempt to ensure sustainability, however the rubbish left from this activity is considerable. I saw no track marking or management infrastructure to ensure low impact in caves. It even appeared that cave visitors did not consider water quality for the villagers further downstream. At rest stops, locals think nothing of leaving their litter, so as the experienced caver present I did my best to influence a better appreciation of the cave environment.

Caving standards

Overall, the caving itself was quite easy, with warm temperatures, but lots of mud and water to contend with. It was decided to avoid any serious vertical access as a number of the group did not possess such skills and considerable training and equipment would have been required. Often on challenging climbs I would place a hand line for the group and talk the non-caves through such a climb. I was amused that some of our local village guides would climb something I would not even consider, and at other times they seemed terrified of something that I thought quite easy.

The language barrier was a source of constant frustration, with lots of misunderstandings and time wasted.....but then most things happen in Indonesian time anyway!

I found our Indonesian team a fantastic group of people; always cheerful, prepared to work and assist in any way possible. Some of them did have previous caving experience and they all seemed to enjoy it.

Core sampling

Core sampling involved using a heavy duty rechargeable drill with a barrel bit. As the barrel is drilled into the base of a stalagmite, water is pumped to keep things cool. Cores of above 12mm were drilled between 5 and 15cm deep, sometimes not coming out as one piece, but it was easy to put the 'jig saw' back to work out the sequence. Each core was bagged and labelled and the core site photographed with its number.

Generally the better sample sites were deep into the cave, high up from the stream way, usually towards the back of upper galleries. Sometimes the most motley-looking stalagmites would give the best looking core sample. A limited number of stalagmites were removed for further sampling back in the lab. Any removals were not in 'plain sight'.

The overall experience

My understanding is that this was a preliminary expedition to determine good sampling sites for future studies.

Naturally such an ambitious research project involves many problems, particularly when negotiating with a foreign government and local officials. A good working relationship with Indonesian research organisations to gain sponsorship, support and local contacts is essential.

On the ground problems included finding a local who could assist in finding cave entrances and even with government permits, further negotiation with local government officers. Having a Bahasa Indonesia speaker was absolutely essential, but even then it is easy to have misunderstandings.

I found the whole experience an interesting one, but many times frustrating. Gaining the appropriate permits was a long and confusing process, and all too often time seemed lost before actually getting into a cave and ultimately very few good sampling sites were found.

Our lack of information on what was actually in the caves we targeted also hampered our success at finding good sampling sites. All my expenses to and from Indonesia were paid, together with permit fees and most day to day expenses whilst on the expedition, but no actual remuneration was sought nor offered. I feel that very few cavers with adequate experience would be available for such expeditions- perhaps only students and retirees, so further expeditions of this nature face a challenge in finding a caver to assist.

The future

For future core sampling, I recommend involvement with Indonesian cavers: perhaps with Australian cavers who known what makes a good sampling site spending some time locating such sites before the core samplers and researchers arrive. This would save the research group a great deal of time and should result in optimal quality samples.

It was fun and some could argue a 'cheap holiday' and a wonderful introduction to the real Indonesia, working and living

with locals. The two A.N.U. researchers returned to Australia in one piece, apart from many bruises and sore muscles, so I guess I did my job adequately!

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Acknowledgements:

Photos: Claire Krause, Nerilie Abram, David Wools-Cobb

Low-Budget Computer Mapping Techniques

Harrison Burkitt

Newcastle and Hunter Valley Speleological Society

Cavers often want to add features to an existing digital map. For example, they may want to add cave locations, limestone deposits, tracks or topography. This paper discusses how to do this in a cost effective way that allows the user to display their maps in 3D.

Superimposing the location of caves and karst onto an existing map allows their positions to be accurately shown relative to the positions of the various features already designated on the map, such as vegetation, geology, elevation and other caves.

OziExplorer is a commercially available GPS mapping program which costs around $120. It is a very good all-round mapping program and is fast at organising GPS data.

Google Earth and Map Tiler are two map viewer programs that are available free of charge. They can be used together as a simple alternative to commercially available GIS programs. They offer 3D viewing of geo-referenced maps, a capability which is particularly useful for mapping and viewing of karst areas.

I find that OziExplorer, Google Earth and Map Tiler work well in conjunction with one another. In this article I explain how to use these programs.

Moving Data To and From a GPS in OziExplorer

At the top of the page in OziExplorer there are 6 small icons with arrows on them. These are for transferring waypoints, tracks and routes to and from a GPS. Three of the arrows are red and three are blue. The red ones are for retrieving data from a GPS, and the blue are for sending data to a GPS.

Editing Waypoints in OziExplorer

Once you have put waypoints onto your OziExplorer map you can change their name, description, position etc. Do this by either double clicking on the waypoint, or changing a select number of waypoints together with the ‘waypoint list’ icon at the top middle of the Ozi toolbar. This will show all the waypoints you have loaded and give you a selection of editing options.

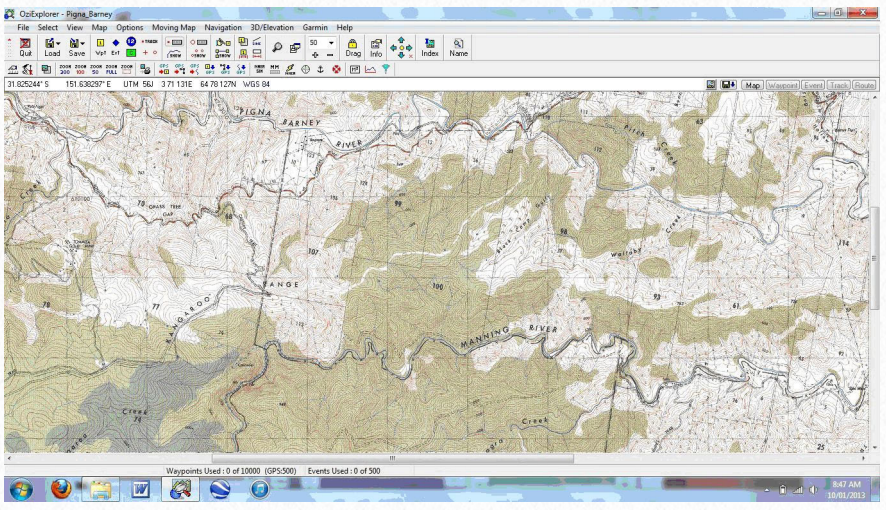
Saving/Loading GPS Data in OziExplorer

To load or import data, use the ‘Load’ icon at the top left of the OziExplorer page. Choose the type of data you would like to load, and navigate to it. You can only load one type of data in one session of Ozi, with the exception of track files that are all in the same directory. But, you can get around this by appending data from files. This option is also in the ‘Load’ menu. There are many other options for importing data into OziExplorer from other programs and files that I do not cover here.

Once you have finished editing and/or making your waypoints, events, points, tracks and routes in OziExplorer, you can save them for future use. Do this by selecting ‘Save’ at the top left of the screen and choosing the type of data you want saved.

Loading Maps in OziExplorer

To use a map in OziExplorer it MUST be geo-referenced. All topographic maps purchased in digital form are geo-referenced. The geo-referencing file that Ozi uses is a .map



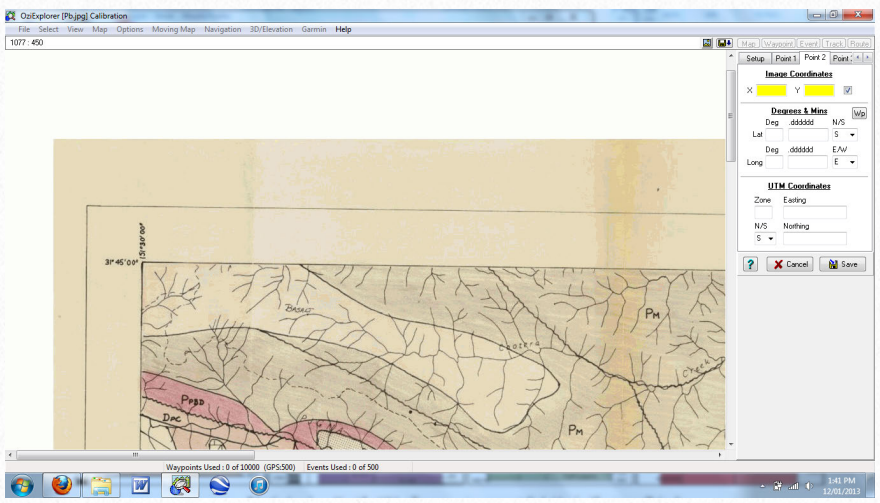
OziExplorer with a map loaded

file. To open a map in Ozi go to 'Load>Load Map File', navigate to where the file is saved and open it. Some image files are geo-referenced without a .map file. To use these in OziExplorer you will need to create .map file for the image(s). In OziExplorer go 'File>Import Map>All DGR Maps on a CD or in a Folder'. Note: If you only need to do this for one map, use the 'Single DGR Map' option. Select the input file and the output directory, and then click 'Import'. The .map file(s) will now need to be opened from the directory into which they were put.

Geo-Referencing Map-Images in OziExplorer

Geo-referencing allows you to locate the position of a map-image on the world. Once you have geo-referenced a map in OziExplorer you can display waypoints, tracks, points, etc. on it. All topographic maps purchased in digital form are geo-referenced so manual geo-referencing is commonly used for older maps. Manual geo-referencing is not always very accurate as you can only get an approximate position. So don't rely on it!

1. Open OziExplorer.
2. Go 'File>Load and Calibrate Map Image'.
3. Navigate to where the map-image to be geo-referenced is located and open it.
4. On the right hand side of the page there will be a window. This is where you enter the geo-referencing data. In the 'Setup' tab, choose name, map datum, magnetic variant (optional) and map projection.
5. After completing this, at the top of the window select 'Point'.
6. Here, you need a point on the map that you know the coordinates of. This can often be found at the corners of the map. Type the coordinates in the 'Point 1' tab. Now use the cross hairs to mark where those coordinates are on the map-image.
7. Do this for a second point on the map by selecting 'Point 2'. Complete this process at least two times and make sure that your points are not on one line of latitude or one line of longitude if you are using only 2 points.

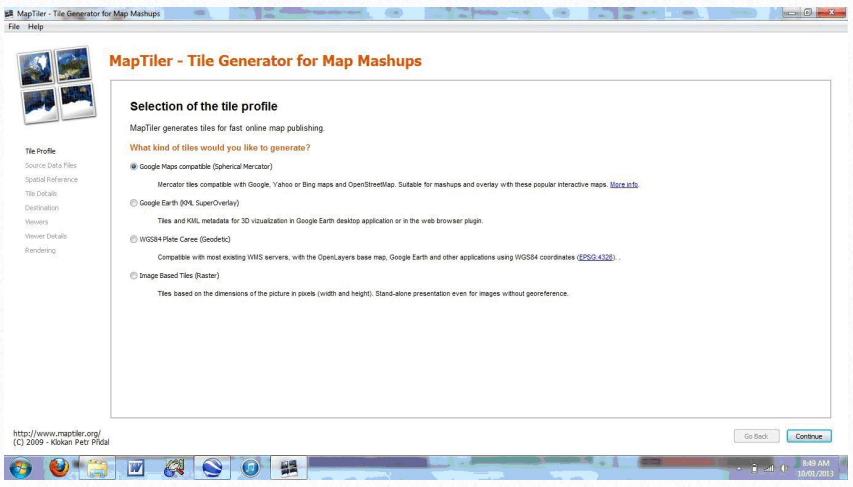


Geo-referencing a map-image in OziExplorer

Using Map Tiler to Make Google Earth Overlays

Map Tiler is a program that creates geo-referenced map overlays. It can be used to generate 3D map overlays for Google Earth. You can download Map Tiler from:
http://help.maptiler.org/betatest/

1. Open Map Tiler and choose the 'Google Earth (KML overlay)' option. Click 'Continue'.
2. 'Add' the map you want. The program will put in the geo-referencing for you. You can NOT put manually geo-referenced maps into Map Tiler. You can create your own geo-referencing using a bounding box or adding .wld, .tab files. Do this by clicking the 'geo-referencing' option. Now click 'Continue'.
3. Select the Spatial Reference System used in your map and put in the necessary coordinate information. Click 'Continue'.



First page in Map Tiler

4. Select the zoom levels (these are normally automatically set by the program for your image). Click ‘Continue’.

5. Choose where to save the new .kml map file. Click ‘Continue’.

6. Select ‘Google Earth (KML overlay)’ option under Viewers. Click ‘Continue’.

7. Choose a name for your map and click ‘Continue’.

8. ‘Render’ your map file.

Using Google Earth with Maps

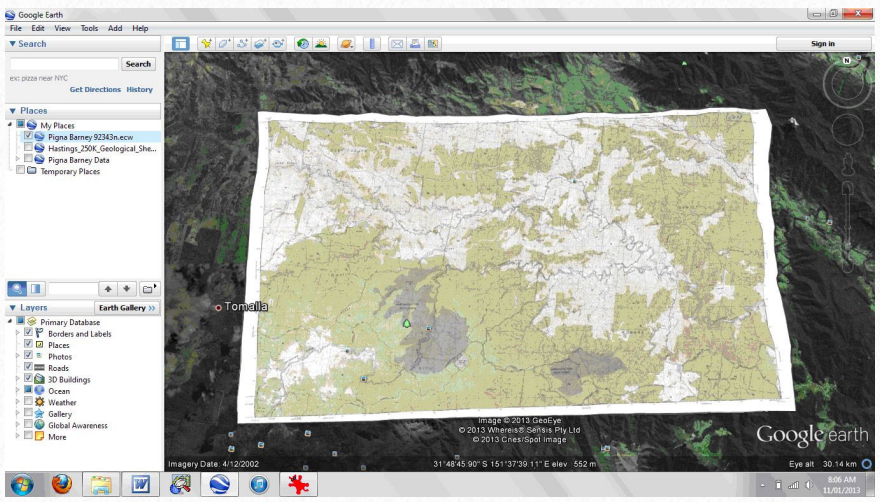
Google Earth in conjunction with Map Tiler is a great way to view your geo-referenced maps. These two programs together offer a simple alternative to programs such as OziExplorer. I personally prefer Google Earth over OziExplorer to view my maps and data. This is because Google Earth offers 3D viewing of maps and orientation of the map viewing angle. I do use OziExplorer a lot of the time because making maps in Map Tiler is a bit time consuming. OziExplorer out performs Google Earth by a long way in GPS data processing.

1. After making a map tile in Map Tiler, open Google Earth.

2. In Google Earth navigate to ‘File>Open’ and go to where the .kml map tile is saved.

3. Open the .kml map tile in Google Earth. Google Earth should then show the map on the screen.

4. Move the map from ‘Temporary Places’ to ‘My Places’.



Opened .kml map in Google Earth

5. Now you can view the new 3D map and adjust the zoom and viewing angle. This is also a good time to load your GPS data into Google Earth.

6. This is where you can view your map in 3D. With the controls on the right hand side of the map screen you can change the direction the map is viewed from, the viewing point elevation, and the zoom.

7. Google Earth divides its display into layers. You can therefore load as many maps into it as you want and flick between the map layers on the left hand side of the screen.

8. If you so desire, you can also adjust the elevation exaggeration and terrain quality under ‘Tools>Options>3D View’. I normally set my elevation exaggeration around 2.

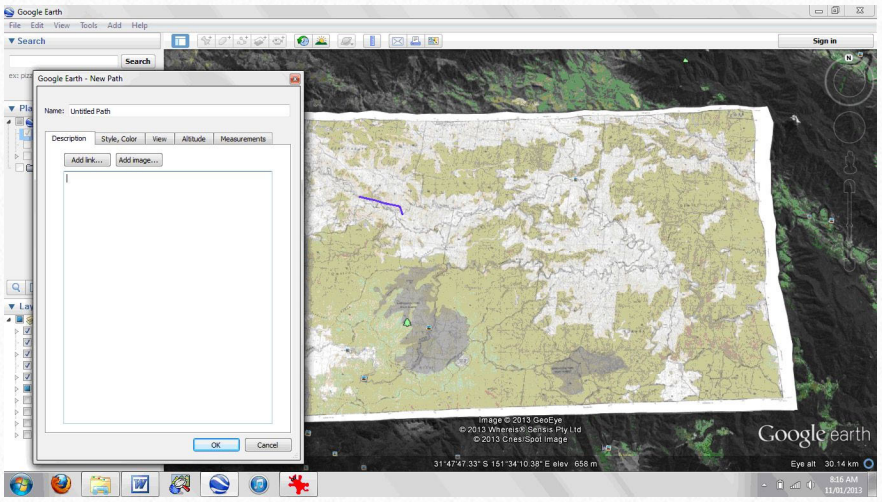
Using Google Earth with Tracks and Waypoints

In my opinion OziExplorer is the best program for editing GPS data. To export data from OziExplorer to Google Earth, go to the ‘Export to Google Earth’ option under ‘Save’ in Ozi. This will take you to a small window. Here all tracks and waypoints that are loaded in OziExplorer can be selected or deselected to save as a .kml file. The faster option is to select the small icon that has a picture of an Earth[1] at the top of this window. It is called ‘View Data in Google Earth’. Google Earth will then open, and your data will be displayed on the screen. It is now best to move (by dragging) the data from ‘Temporary Places’ in Google Earth to ‘My Places’.

In case you don’t have OziExplorer, Google Earth has the ability to create waypoints (thumb tack at top left) and to retrieve data from a GPS. To retrieve data from a GPS in Google Earth go ‘Tools>GPS’ and select the appropriate options.

Manually Creating Tracks in Google Earth to Show Limestone Deposits

The best program to use for this is Google Earth. You can use OziExplorer but its capabilities are limited. I find that the method described here is a good way to map limestone deposits. Before you map a deposit though, you must have overlayed a map in Google Earth to use as a reference guide. You should also have a geological map of some sort which you can infer from.



Plotting out a limestone deposit in Google Earth

1. Open Google Earth.

2. Overlay a map in Google Earth (refer to earlier instructions).

3. Select the 'Add Path' icon at the top of the page. This is a picture of a line with three dots on it.

4. Now a 'New Path' window will appear on the screen. In this window you can add description, name, width and colour, for your path. DON'T close this screen while making a path.

5. A cross hair will now appear on the screen. Create the first track point by a single left mouse click, then a second, then a third ..... You can thus encircle the deposit with small straight lines. If you hover over a track point, you can left click on it and move its position. Delete track points with a right mouse click.

6. If you want to export your finished track to OziExplorer, right click on the track under 'My Places', and select 'Save Place As ...'. Choose where to save it, and save as a .kml, NOT .kmz.

7. Now you can open OziExplorer and select the 'Load' icon and click 'Import Google Earth (kml) File'. Navigate to where you saved your track (.kml file) and open it.

8. From here on, refer to my instructions on 'Using Google Earth with Tracks and Waypoints'.

Conclusion

Google Earth and Map Tiler are cheap, effective, and easy to use. These two programs combined allow cavers to view maps showing geographic features in 3D. OziExplorer is a good addition to these programs because of its GPS data processing capabilities.

Comments and questions are most welcome. Please email at harrisonburkitt@gmail.com

Bedrock, fills and cut surfaces: the story from Pungalina, Golden Valley and the Nullarbor

Henry Shannon

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Cave walls can be a feast of information for those interested in the geology because the exposures can be very good, clean of obscuring soil and vegetation and with enough length of exposure and etching effects to give an advantage over, say drill core sections. The story to do with bedrock geology is the most obvious one to follow and is illustrated by examples from Pungalina, NT and Golden Valley, Tas. But there is also another story to do with cave breccia fills, illustrated by examples from the Nullarbor SA and travertine deposits in the special case where they are affected by re-solution episodes illustrated by some examples from Pungalina. The story thus moves from caves merely as exposures to do with conventional geology more into something specifically speleological.

FIGURE 1. *Sample of* Conophyton *from Ballroom Cave*

At Pungalina

Commentary on the measured sections, and geological notes

Sections through the strata were measured in Balconies Cave and in Totem Pole Cave during the 2010 expedition. Both caves contain a “tuffaceous” section in the entrance zone of around 10 metres with stromatolites that include simple low dome and “pudding basin’ types and do not include Conophyton above a section dominated by Conophyton, also of the order of 10 metre thickness. This has an upper portion in which the cones can be huge, divided by an interval most commonly including a green shale bed 1.5m thick, from more Conophytons in stacked columns on a smaller scale; these commonly weather brown in cave exposures. At the top of the Conophyton-dominated interval, smaller and deformed versions of the stromatolites develop which have dish forms between the stacked-cone columns. As the sediment associated with them becomes pinkish-brown tuffaceous mudstone rather than clean carbonate sediment, the cones become smaller overall and the dishes make up more of the colonies. Continuing input of this type of mud evidently killed off the Conophyton. The two sections correlate well down to the base of the Totem Pole Cave exposure which is thought to bottom at just below the first flourishing of Conophyton.

FIGURE 2. *Sample of “gargoyles” from Balconies cave (level with the head of the figure)*

The Balconies Cave section gets down considerably lower: its interval 24.1-24.35 is considered to correspond to 27.0-27.25 in Totem Pole Cave, at the very bottom of that measured section, and a marker just below the start of large scale Conophyton bioherm development. 8 metres lower comes the distinctive chert-replaced columnar stromatolites that make up the

gargoyles, and 2 metres lower still is the top of the interval with platy chert in which most of the cave is developed. This would appear to cover 6 metres of section with the base under water.

At the surface there is a cherty yellow dolomite unit present around Balconies cave and its approaches that is not present At Totem Pole Cave. The next bedrock unit up sequence is a sandstone mapped as Cambrian age Bukalara Sandstone but now thought to be part of the McArthur Group sequence, and therefore something else and as yet unnamed. The distribution of both these units hint at minor unconformities at the base of each. To illustrate this point the top tuffaceous section is present at Great Expectations Cave and its approaches and in the surrounds are the cherty yellow dolomite and further out, the “false” Bukalara Sandstone. At Bauhinia Sinkhole the sandstone is at surface presumably with dolomite below. At Totem Pole cave neither the sandstone nor the cherty yellow dolomite appear indicating non-resistant rock, most likely shale-dominant from a continuation upward of the tuffaceous section.

It is very likely that the gargoyles in Gargoyle Cave are the exact same horizon as the gargoyles in Balconies Cave; the brown-weathering Conophyton in Breccia and Ballroom Caves the same as the Lower Conophyton unit in Totem Pole Cave and the giant Conophyton in Conophyton Cave that of the upper Conophyton unit. It would seem that the caves of the area may be all in a dolomite interval barely 40 metres thick!

During the 2012 expedition another measured section was done in Conophyton Cave a few kilometres from Gargoyle Cave. A gargoyle type stromatolite bed was found low in the cave, of the same general nature as the one in Balconies and in the same position with respect to the major Conophyton development. In this cave the Conophyton zone is thinner, it stops at the entrance, there is no tuffaceous zone and just outside there is a form of flaky chert with small scale stromatolites in a kind of box cell construction with empty centres. This is also seen outside Balconies Cave so part of the sequence has been chopped out here. A nearby summit is capped with False Bukalara sandstone/conglomerate.

There is long standing uncertainty as to how the Karns Dolomite relates to the sequence seen at McArthur River to the west. Clearly the Karns Dolomite is a reduced and truncated

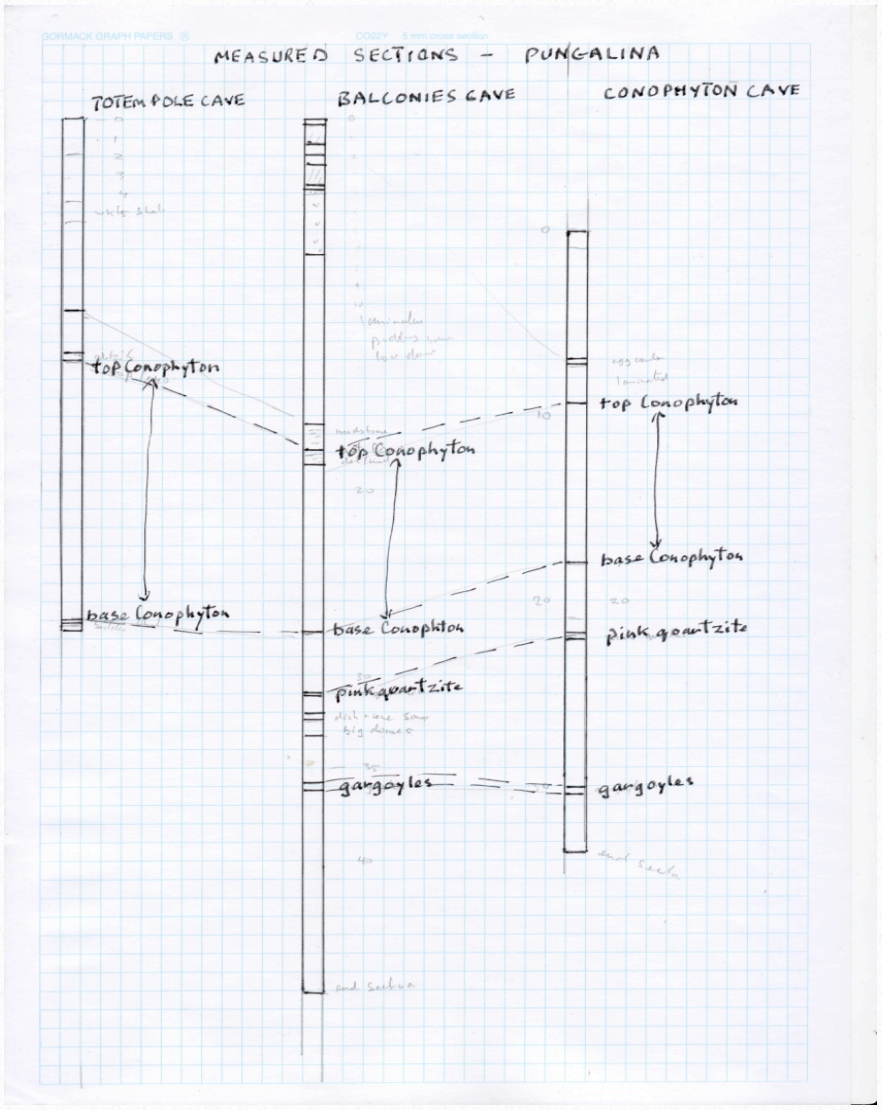

FIGURE 3. *Measured sections - Pungalina*

equivalent of the much thicker and complete sequence at MacArthur River, but is it equivalent to only to the Nathan group at MacArthur River, that is, the upper part as suggested by NT Mines Department staff or does it equate to the McArthur Group below? In the Pungalina area the rocks resembled bits out of the part of the Umbalooga sub-group of the McArthur Group that I used to work on at McArthur River: the Mara Dolomite (lots of Conophyton), the Barney Creek Formation (impure dolomite with tuffaceous material – a bit of shoehorning required) and Reward Dolomite as defined by Carpentaria Exploration (yellow cherty and no Conophyton). No rocks resembling those that are distinctive in the Batten sub-group sequence were seen but I am told (Maxwell Brown pers. comm.) there is an Upper Karns Dolomite outcropping along the N-S trending stretch of the Savannah Way West of Pungalina, which is stratigraphically above the “false Bukalara”, in which Batten sub-group rock types are present.

For the moment I am inclined to think of the Karns Dolomite as seen at Pungalina as a reduced and truncated version of the Umbalooga sub-group of which I have seen only the upper portion. I suspect what has happened is that when

deeper water deposition took place in the McArthur area (Batten Trough) deposition could occur in the Karns Dolomite area (Wearyan Shelf) but not otherwise; so that where evaporite/mudcrack rocks were happening to the West, non-deposition or erosion happened instead on the shelf to the East. The "false Bakalara" would seem to be terrestrial sandstone represented in the Batten Trough by marine sandy dolomite in the Lynott Formation at the base of the Batten subgroup.

At Golden Valley

A cave in and around the basal unconformity of the Tasmania Basin, only partly in Gordon Limestone

The least aberrant of these new-to-us caves is Whatleys Hole which is at least partly in Gordon Limestone, in pretty much the very last exposure of a belt that goes to Mole Creek largely in subsurface. The rest of the cave is in the Stockers Tillite that is the basal unit of the Tasmania Basin sequence running from Late Carboniferous through Permian into the Triassic. As you stand in the cave passage from about waist down the rock looks like slate but is actually impure limestone with a lot of mica partings along a bedding plane cleavage, your head is in a ceiling channel what looks like conglomerate but the stones are faceted not rounded and so are essentially glacial, and the matrix is unsorted looking so it can be called reworked tillite. It is undercut where a weak layer about 30cm thick has been preferentially removed to make a shelf which is at and above the glacially cut surface on the Gordon Limestone. But there are surviving patches of the preferentially attacked rock remaining on the glaciated surface. It is a rock compositionally limestone judging by etched surface effects but also actually tillite. It is not uncommon for a till to derive almost entirely from close by and there would have been enough Gordon Limestone immediately to the south and west to provide a limestone-ground-to-rock-flour source for the original till. We have here a paradox in that the tillite is more of a cave-forming limestone than the Gordon itself at this point, and is preferentially dissolved out. The situation here matches that to be seen in Marakoopa Creek at the waterfall upstream of the track crossing going to Devils Pot, where there a thin basal deposit of more ordinary true tillite with very similar reworked tillite above it. At this locality it is possible to see glacial striations on a rock nubbin projecting on the unconformity surface. The cave does not appear to have any connection to modern drainage and in this respect is like the caves up the hill. Bear with me for going all geological but this is highly significant, geological monument level stuff and there is much more to caves than pretty stalactites and creepy-crawlies.

FIGURE 4. *Stocker's Tillite resting on Gordon Limestone*

Some caves partly in a thin limestone at the top of the Glencoe Formation, but extending into Billop Formation

The next lot of caves are up the hill in a small escarpment below the Whatley's house. Going up the hill the rock sequence goes Quamby Mudstone, Glencoe Formation (fossiliferous with dropstones and minor limestone) Billop Formation (a fairly resistant silty/sandy matrix rock packed with fossils and glacial dropstones), Macrae Mudstone, Liffey Sandstone. The Billop Formation is resistant enough to cause the bench the house is on. The limestone of interest is just underneath it, so potentially following the Billop across the country and looking just below it is the way to spot any more caves. Note this limestone is not the same thing as the better known Permian limestone over on the East Coast of Tasmania, which has a few caves in it and hosts fauna 5. Caves have not been previously even been suspected to exist in Glencoe Formation limestone which has fauna 2. It was thought that there were only thin and sporadic beds of limestone present on the strength of a borehole section nearby but the limestone reaches nearly 7 metres a few km East along Quamby Brook.

The caves in the limestone at the top of the Glencoe Formation on the Whatley's property are at the base of minor cliffs in the Billop Formation and have ceilings of Billop Formation material. This is best seen in the Kids Cave which is widest at the formation boundary. The ceiling is studded with the drop-

FIGURE 5. *Upper half is in Billop Formation, and bottom half is in Glencoe Formation*

stones falling to the seabed from floating icebergs to the inconvenience of the shelly fauna of the time which makes up around 20% of the rock, limy enough to produce a patch of stalactites. The part of the wall underneath is limestone and it slopes evenly to a floor canyon; giving a typical cross section for a karstic cave. The other cave near the house is a flattener with a draught, recently dug enough to see to the next bit that has to be dug to see any further. A new cave found among the blackberries is bedrock floored with the limestone only about 30cm thick in the walls. It is wet belly crawl to what looks like an old mudbank. None of these caves amount to much at the present but they are clearly unrelated to modern drainage and make best sense as ancient features related to basin-wide artesian circulation. So if the entrance blockages are passable the caves might just keep going, but as belly crawls?

On the Nullarbor

Nullarbor fills story

The caves that have been turning up on the VSA expeditions have preserved features of some rather odd geology giving an idea of happenings later than deposition of the Nullarbor Limestone and prior to development of the powdery pinkish brown surface soil. There is more to the typical blowhole than the small vaguely vadose cave cut in Nullarbor Limestone, starting in a doline in the same rock, with a bit of dirt around it, assumed to be derived by weathering of the limestone which is what one might expect from a superficial account of Nullarbor blowholes.

FIGURE 6. *A representative blowhole entrance shaft*

FIGURE 7. *Grey clast limestone breccia at surface*

Figure 8. Calcrete horizon surrounds caprock entrance partly in grey clast breccia

Figure 9. Detail of grey clast breccia as caprock

FIGURE 10. Shaft entry of 5N4618. Partly developed in three generations of earlier fills

Pretty well all the caves are of phreatic character with the typical shaft being a stack of blobby ellipsoid forms and passing down into spongework in situations where a cave gets beyond the entrance blockage effect of a stream coming in from the entrance, which tends to just fill in the cave without doing anything to adjust wall sculpture. The dongas– big level flats at the local low points – typically lack cave entrances, and according to what the wombats show us have thicker earth cover.

The entrances can occur anywhere but mostly on the sort of steeper areas out from the dongas. Many entrances show evidence that they are formerly closed cupolas that have just broken the capping. Furthermore many are partly in breccias

FIGURE 11. *The pipe which contains dark grey clasts is inside a larger and older pipe with pseudofulgarites (bent rods formed along roots in sand dunes as a rule) from Footprints Cave 5N4745. So far the breccia type dominated by pseudofulgarite clasts has only been found in this cave. It is interpreted as sampling a vanished landscape with coastal foredunes which preceded the development of the commen black limestone often seen in pipe fills.*

which post-date the Nullarbor Limestone itself and which themselves are fills of former caves very like the ones that are there now. The implication is that cave development on the Nullarbor is essentially old and relates to a time when the water table and presumably some ground, was above the present surface. Also that the site of a blowhole tends to persist as a cave and be repeatedly re-established.

Where pipe fills of breccias of differing character have cross-cutting relations some kind of event sequence can be sorted out, as is the case in the photo on the right where there are 2 generations of grey clast breccia rimming a core of pink breccia, all filling a previous shaft, and exposed in the present open shaft. The strange rock types in the breccias show what once existed at the surface and has now gone. The fills give evidence of a vanished surface geology. The breccia clasts of black unfossiliferous limestone are sometimes coated with laminated buff limestone (probably developed in soil; that is the black is the core of a rudimentary pisolite; a concretion growing like a pearl in an oyster). This black limestone is intriguing stuff, it would seem to have formed in a toxic lagoon of some kind. There is a later breccia fill found only in Footprints Cave so far, where there is a pipe within a pipe. The outer breccia pipe has clasts with the black limestone; the in-

FIGURE 12. *Well developed pseudofulgarite bits and pieces etching out of breccia, note absence of black limestone clasts.*

FIGURE 13. *Peeling crust of cave coral exposes marine fossils*

FIGURE 14. *Older travertine with column engulfed by subaqueous layered travertine*

ner is packed with pseudofulgarites – calcareous concretions which encrust roots in coastal dunes. There is also some red-matrix breccia, not so consistently lithified which would seem to be later.

There is also travertine of more than one generation. Cave coral is abundant most commonly as a crust which is peeling off under present conditions though some is active. Travertine which is dark brown but otherwise of normal, humid climate forms is common and earlier generations have been redissolved as part of the wall in the present open caves though necessarily deposited in an earlier cave, at that time air-filled. Later on the former airspace has been filled with horizontally layered travertine deposited underwater. So the high water conditions have been interrupted by low stands occurring in a wet climate. The older travertine may even pre-date the earliest breccia pipe fills.

Later travertine looks just like ordinary cave formations but usually shows some breakage relating to floor subsidence and salt wedging. Washed in earth and stones are built up against these formations. The climate has changed away from something genuinely wet.

There are samples of a geology later than the lithification of the breccias. There is red sand found in some sinkholes and as reworked sand in a few caves. Is this the local expression of the Parilla Sand of the Murray Basin? The Parilla makes up dozens of beach ridges inland from Naracoorte. Later still comes the calcrete and pinkish dust which make sense as a

FIGURE 15. *An example of red sand*

wind-blown deposit somehow related to the Bridgewater Formation. The calcrete layer goes further than the Nullarbor and isotope studies match it to seawater implying that the calcium come down in the rain. The earth component does not resemble what could be expected as residue from dissolving the Nullarbor Limestone, but is possible for the dust of dust-storms. It is within this deposit that the tektites are found so it was there 800,000 years ago. At some time previous it would seem the Nullarbor was largely stripped back to bare rock.

Pungalina again, dealing with travertine mainly.

Quite early on in the VSA Pungalina project Jacques Martini (a geologist from Switzerland who worked professionally in South Africa) identified 4 phases of travertine deposition in Ballroom Cave, which is a big one for the area, well decorated and easy. But I needed to work out for myself what he meant by the 4 phases, and this required some thinking time on the spot. So, the presumed phase 4 would be the various stalactites stalagmites and flowstone which have intact depositional surface, microgours and the like; and phase 1 would basically be the very old white flowstone which shows evidence of having been through a large scale re-solution event, in which the old flowstone mass shows the same style of scoop-out hollows as the bedrock dolostone next to it. In other words after being an open air-filled cave with travertine deposition on a large scale there has been a return to underwater conditions (phreatic) in which the travertine and original dolostone have been corroded out without distinction, to make a new cave in roughly the same place as the previous one. To work out the other phases, it could be seen that there was a sequence break in the older material, best seen in big severely corroded columns, cutting right into the formations to expose the growth lines in the travertine. Here the younger material included predominantly yellow to brown and thin bedded, variously coloured travertine, and because of the degree of corrosion the growth lines were conspicuous. All four stages are visible in Figure 14.

The implication is that return to phreatic solution occurred twice. And working back from the phase 4 stalagmites there were others which had been corroded but only to the point of being peeled back by a few centimetres and preserving the overall shape of the original formation. This may be just a

FIGURE 16. *The four Martini phases of travertine:*
1 white
2 multicoloured
3 small canopy boss corroded back
4 ordinary stalactites

FIGURE 17. *The Dragon in Ballroom Cave: a four phase travertine mass*

subaerial weathering effect but another but a shorter return to phreatic conditions is indicated.

The caves of the area occur in a restricted height range with respect to the water table so there is potential for correlation of the stages between caves, since what is being attempted is matching of corrosion events linked to regional water table rises and falls. Totem Pole Cave however does not have any of stage 1 or 2 probably because the extensive rockpile section relates to collapse that was later. There is plenty of stage 3

(notably the actual Totem Pole stalagmite). Balconies Cave entrance cavern has some stage 1 and probable stage 2.

Consider the underside of the travertine mass above the figures. The fringe of shawl/stalactites is stage 4 travertine built up on a base of stage 3 travertine which has been corroded back to expose growth lines inward from the fringe to the margin of the buff/creamy travertine. The red cemented breccia is stage 2 and includes a blocks of stage 1 travertine, one quite large and with only rudimentary banded travertine. The main white, massive travertine (some grey) is stage 1. The triangle of brown rock at the right hand edge is bedrock. Note that the cut of the cave wall runs smoothly from the white travertine on to the brown dolomite.

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The history and future of Wyanbene Cave or "A Wyanbene Carol" with apologies to Charles Dickens

Robert Kershaw

Illawarra Speleological society

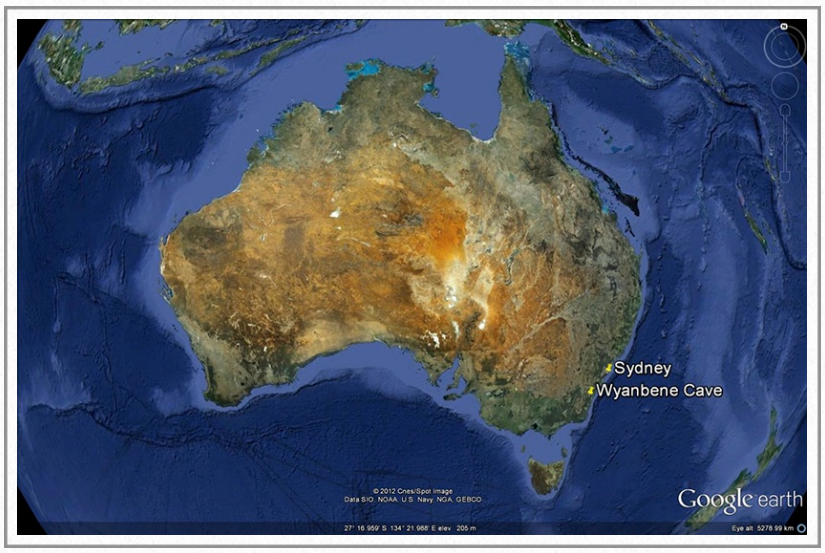
Introduction

The Wyanbene Cave system has been used extensively since its discovery in the mid-1880's by caving club members, speleologists, members of the Scout movement, other youth groups and for Emergency Service rescue training. A great deal of intentional damage has been noticed in the tourist section and unintentional damage has been done to the cave beyond the locked gate, since the extension to the end of the cave was found over 50 years ago. Little has been done to educate users or to restrict access to paths in well decorated areas or to rehabilitate the cave. Cave managers have restricted access by the use of a gate since 1986 and a permit system presently exists and it is intend to continue the permit process in the future in a more restrictive manner. In October 2011, members of Canberra Speleological Society and Illawarra Speleological Society encouraged the idea of a cleaning project to enable extra trips into the cave under the revised permit system implemented by the local office of NPWS to assist in the rehabilitation and education of users.

This paper briefly examines the history of use of Wyanbene cave, the present Management plan in regard to access and the future cave cleaning program.

Location

Wyanbene Cave is located 70 kilometres south east of Canberra, 250 kilometres south west of Sydney and 40 kilometres south of Braidwood in the Southern Tablelands of NSW. The cave is within the Deua National Park of South East NSW and the Big Hole is nearby. These short distances make it an accessible location for cavers to visit the cave.



History of use by speleos and other cavers

During the mining of silver near the cave, the water from the cave was used to supply water to the activity. (Anon 1889)

Trickett (1899) reported that an iron gate and ladders were installed at the entrance for the protection of the cave. The gate and ladders cost 27 pound 12 shillings and 7 pence in 1889.

These ladders are still used today to enable tourists and cavers to reach the "Bat Chamber" and are in good condition.

In the late 1890's to early 20th Century the entrance Stream way and "Tourist Section" were open to the public, and electric lights used in the late 1920's to show tourists around the cave.

Dew and Pemble (1957) identify numerous bats and 2 spider species in the Main Cave.

A 1966 description of the cave noted that most of the formations were a dirty brown colour along the stream way passage from the Keyhole into the cave. During May, Garrington (1966) notes that a ladder at the entrance and just through

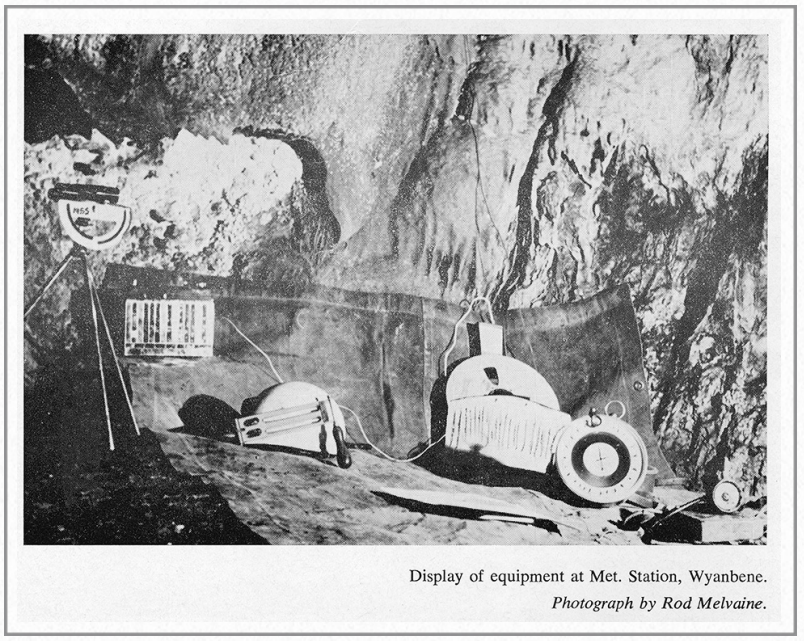
Picnic at Wyanbene Caves late 1920s
This is a photograph of a picnic at Wyanbene Caves. The day was organised by A generator was organised to put electric light through the caves. Jim Dempsey assisted, by following behind the crowd and putting out lights as they moved forward to provide more light in the front.

FIGURE 1 *Tony Baxter (Green Helmet) NPWS Manager Deua Region on inspection tour of Tourist ladders in Wyanbene Cave February 2012*

FIGURE 2 *Ian Chalson at Wyanbene Entrance gate. Photo Bob Kershaw, March 1978*

the keyhole had been removed and that a lot of damage in the Cleopatra's Bath area had occurred. His party also named Diarrhoea Pit. Halbert (1966) reported that his party found surveyed and named Chamber Pot and found a way to Frustration Lake and that Perkins swam the lake trying to find an exit, albeit unsuccessfully.

Dean (1967) and other members of MSS took radio communication gear, portable gas stove and meteorological equipment to measure the weather at the keyhole.



Display of equipment at Met. Station, Wyanbene.
Photograph by Rod Melvaine.

FIGURE 3 *MSS weather station set up*

Booth (1967) noted that his party found many flash bulbs, fruit skins, paper and large blobs floating on the water surface and on rocks.

A great deal of exploration occurred in the cave in the 1960's to find where the cave was in relation to the surface and if extensions could be found. But alas no extensions were found.

Call (1970) noted that NUCC used balloons filled with Hydrogen to measure the Gunbarrel aven at 346 feet.

During the 70s and 80s many parties entered the cave on the same weekend and as many as 7 at one time were reported. Often groups used each other's gear and the public often wandered in using caving clubs' equipment. At one time Halbert (1982) stated that there were 6 ladders hanging down the pitch after the keyhole.

A radio direction finding activity in 1970 by Wellings and ISS members was undertaken to find the location of the Gunbarrel aven in relation to the surface to see if there was any surface entrance to the cave near this point.

In the early 70s NUCC led by John Brush completed an exacting survey of the cave and produced a map that is used as a basis for the 2012 cleaning survey.

Pavey (1972) mentioned that Cleopatra's Bath was suffering from the constant use by cavers.

Hurst (1973) led a diving Recon party with no gear into Frustration Lake. They retuned a few months later with gear but found no continuation.

1973 onwards saw the invasion of ISS members with a helium balloon exercise to take photographs of the Gunbarrel Aven and roof. In 1975 they confirm the height as 367 feet and took

FIGURE 4 *Ladders below Keyhole Pitch in Wyanbene Cave. Photograph by Ross Ellis (Sydney Speleological Society) January 1982*

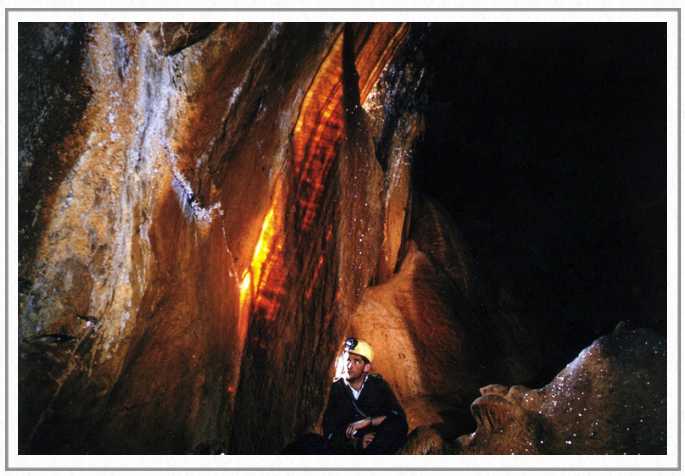


FIGURE 5 *Note the shawl to the left.*
Photo by Lloyd Robinson circa 1962

FIGURE 6 *Note the shawl is broken.*

FIGURE 7 *Entering the Cleopatra' s Bath area with muddy clothes and boots.*
Photo by Deborah Johnston

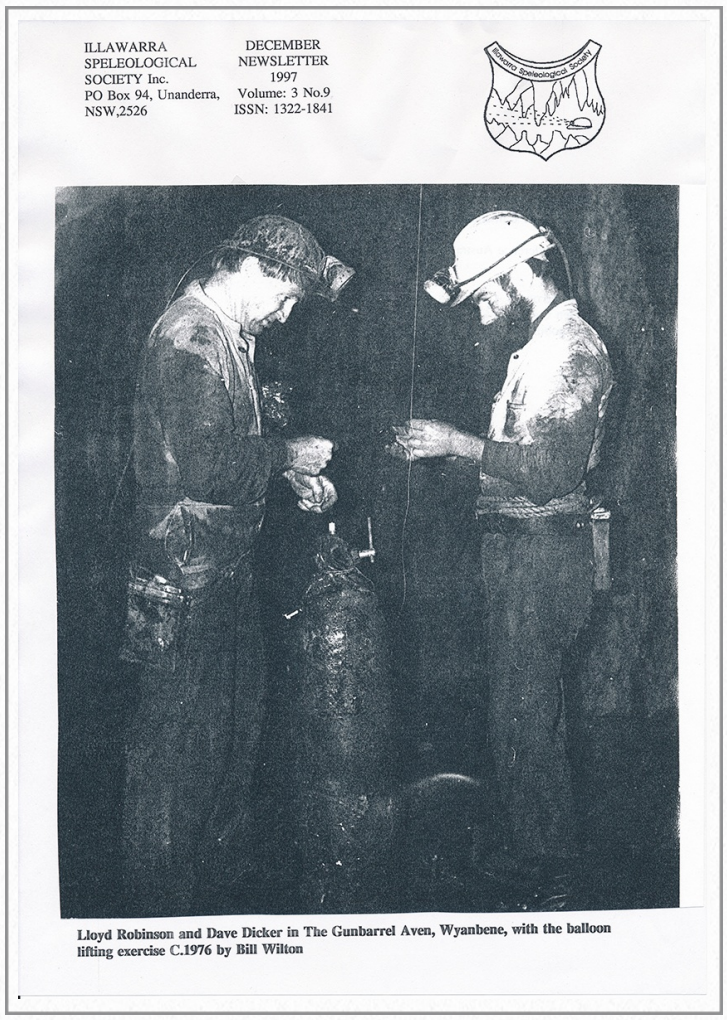


FIGURE 8 *Hydrogen filling of cleaning balloons by ISS*

Cavers go to good areas after the mud sections and do not remove muddy gear or boots. The photos on this page depict some activities undertaken in the cave. You can think of the resulting damage to the cave.

many photographs. In April of that year Wilton (1975) described another RDF attempt and cairns being constructed on the surface to locate underground positions. In 1976 ISS again sent balloons aloft in the Gunbarrel noticing a severe cross current 200 ft above the bottom of the aven.

Warild (1977) reported that he spent several hours attempting to climb the Gunbarrel Aven but had to give up at the 63m height as he could climb no further.

Coggan (1974) reported that NUCC conducted a trip for a submission for a gate for the cave so that some degree of protection can be afforded to the cave.

Various filming activities took place in the cave during 1978 and 1979 by ISS and WIN TV.

Davey (1978) wrote a submission to the NSW Under Secretary of Mines objecting to the inclusion of the karst and caves in a proposed exploration licence.

Dicker (1979) reports that several strain gauges were installed in the cave to measure rock movement. These have proved over the years that little movement has taken place.

A gate was installed in 1986 at the keyhole but with limited success and in 1987 a new gate was installed but had been removed from the wall in 1995 (Rowling ~ 1995)

During 2003, 2005 major cave rescue exercises are conducted in the cave and many rescue service personnel are involved.

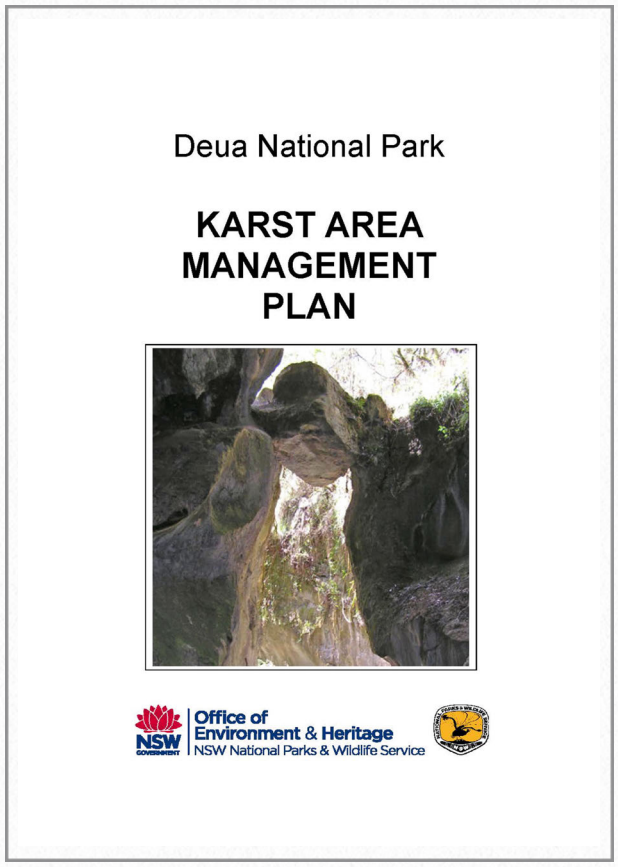
Karst Area Management Plan

In June 2003 Kershaw (pers Comm) suggested to author of Far South Coast Parks Management Plan meeting that there should be a management plan for the caves within the Deua Park.

Coogan and Brush take NPWS personnel who will be drafting the karst plan into Wyanbene Cave during 2004 for a first-hand experience of the cave. They later meet with members from ISS in Canberra for a meeting regarding the karst plan.

The staff of the Far South Coast NPWS region produced a draft Karst Area Management Plan but then the Karst and Geodiversity Unit in Oberon rewrote the draft and presented it to the Director for signature. But it was not presented to ISS or CSS to comment upon before signature. There were many glaring errors and restrictions in the Appendix 4 of the plan.

At a meeting in November 2011, as a method of overcoming the 6 trips per annum in Wyanbene Cave, Brush and Kershaw



presented a cave cleaning proposal to the Manager of the South coast or Deua National Park.

Please contact John Brush (johnbrush@ozemail.com.au) or Bob Kershaw (rkershaw@ozemail.com.au) for electronic copies of the Deua KAMP.

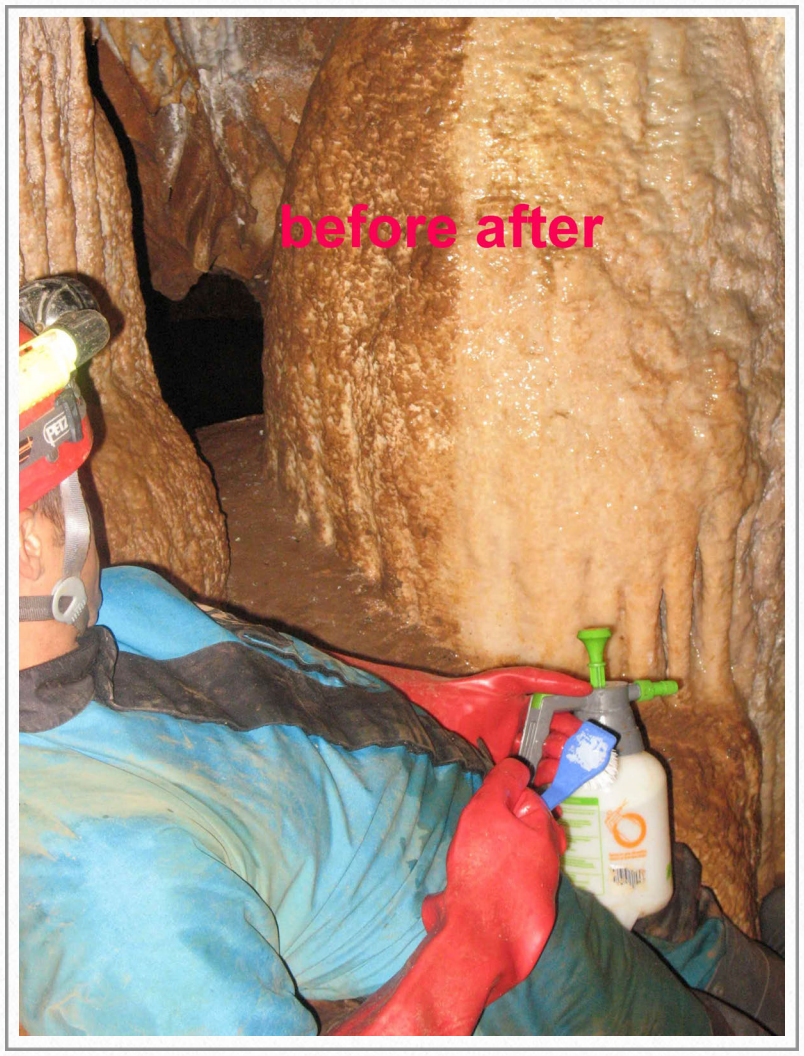
The Future - Cave cleaning project.

The Cave cleaning and rehabilitation project will:

- Provide education to all cave users (not just speleo societies) to take care of karst environments and encourage low impact caving (not just here but within all caves in NSW).
- Increase good name of speleological societies in the SE of NSW with NPWS and with non-speleological Society cave users
- Encourage all members especially youth and new members in CSS and ISS to take care of karst environments
- Enable, support and encourage other cave users (non-speleological societies) to be involved in Karst care
- Provide a karst care project example that will enable and encourage other Australian Speleological Societies to undertake similar projects within caves in their areas and to use the learning from this project within their own projects.
- Enable NPWS managers in other parts of NSW to see what could be done with caves in their area and that a good relationship can and does exist with the speleological organisations

FIGURE 10 *Cleaning in the entrance streamway*
Photo Bob Kershaw

FIGURE 11 *Marj Coggan Cleaning in Wyanbene Cave*
Photo by John Brush



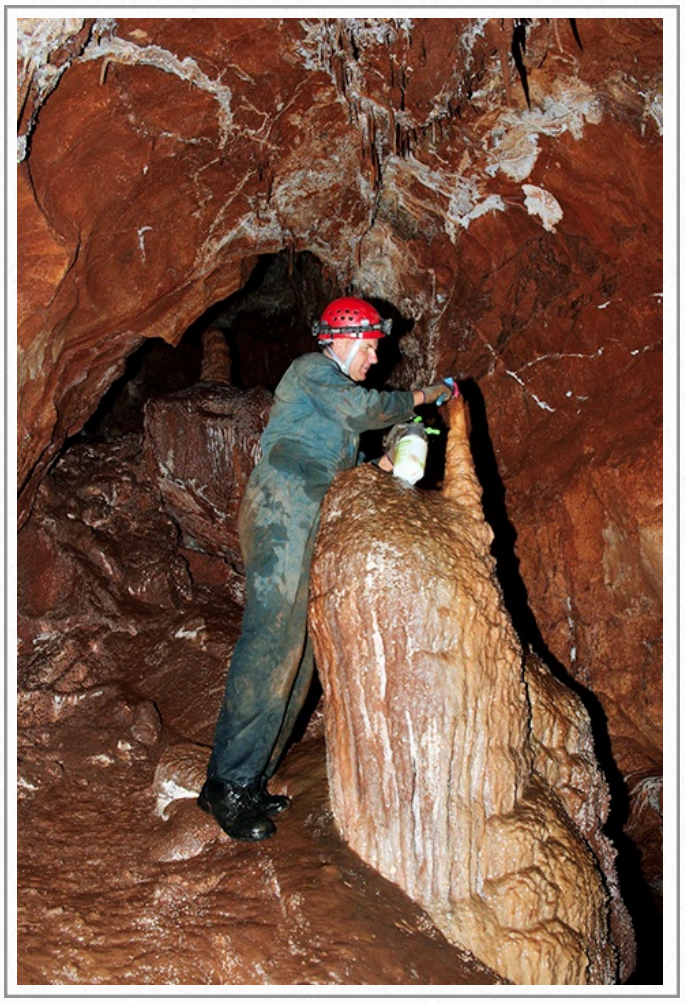


FIGURE 12 *NPWS worker cleaning area in ladder pitch chamber*

The specific aims of this project are to:

- rehabilitate significant features in the cave (such as decoration, wall and roof features and sensitive floor areas);
- minimise further damage to the cave system by providing track marking and signage in selected areas; and
- educate users in conserving the cave

The project will be conducted in the following framework

- Utilising the NPWS Access Permit system to educate and promote the Karst care project, track markings and other low impact caving requirements.
- ISS and CSS will manage the project and undertake extra trips to the cave to pursue the project and will encourage and promote other speleological societies to become interested and also participate
- The project will be using GIS software to keep track of areas or formations cleaned and a log of activities kept for future reference. Photographs of before and after cleaning have and will be taken to provide evidence of the success of the venture.

This is a long term project and the results will be shown to the NPWS and NSW cavers through photographic evidence, trip reports of clubs involved in the project, and Caves Australia articles, and a paper for the ASF Conference in 2013 (reports to NPWS on the project that will educate & inform other NPWS Karst Managers of the project and its outcomes)

FIGURE 13 *Formation near Cleopatra's Bath before cleaning*

FIGURE 14 *The same formation, after cleaning*

Involvement and liaison with NPWS

The Senior Management of the NPWS Far South Coast Region support the karst care concept for Wyanbene and are investigating options to provide funding, materials and staffing support to assist in the management action plan and initial cleaning project.

The NPWS Officers in Deua Region based at Narooma obtained this finance under NPWS "Find it and fix it" program.

Conclusion

The process of cleaning Wyanbene cave has been more than successful and has rejuvenated many dirtied formations within the small areas cleaned to date. We have uncovered a few interesting formations that have been covered by mud for decades and this inspires us to continue cleaning various areas in the cave. A few pieces of ingrained graffiti that have been visible for years have been removed and improved the aesthetics of the cave for the general public in the entrance stream way and the Old Tourist Section.

Welcome to Wyanbene Cave

Be one of the visitors to Wyanbene Cave who are talking about how great it looks.

"As a frequent visitor to this cave I have noticed a decrease in damage to formations and mud being tracked through the cave. The cave cleaning and restoration project being conducted by the speleological (caving) clubs and the NPWS has greatly assisted in helping me to reduce my impact, still enjoy the challenges of the cave and to have a fantastic view of the formations." Kerry from Canberra

Enjoy viewing the formations and cave passages by walking in the stream whilst in the entrance stream way and avoid walking on the muddy areas.

Caves are fragile environments. So take care but also take your time to look around and delight in your experience in this section of the cave.

Thank you

Illawarra Speleological Society, Canberra Speleological Society and the Narooma Office of NPWS.

For more information on caving or clubs go to www.caves.org.au

FIGURE 15 *The positive sign messages for the public that have been placed inside the cave*

It will be interesting to hear the feedback on the positive messages left on the signs to see if they make a difference in attitude to occasional visitors. Another idea is to leave laminated photographs of the areas before they were cleaned so that the public and cavers can see the difference and hopefully not dirty the cave in future.

We would like to thank the Narooma office of NSW NPWS for their assistance and the ASF Grant Fund for assisting us with the purchase of two hire pressure fire fighting portable back pack sprays that have proved invaluable in cleaning decades of mud from the formations.

There is a great deal to complete in this long term project and CSS and ISS encourage users to complete some cleaning in their trips into the cave in the future.

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Appendix 1 information given to NSW Speleological Clubs

Wyanbene Cave Restoration Project

Preliminary information

Canberra SS, Illawarra SS and the Narooma office of Deua NPWS are embarking on a cave cleaning/restoration project in Wyanbene Cave. After many years of public, speleological and other group use, the cave has seen a great deal of mud build up on formations, some of which has been inadvertently passed from one section of the cave to another.

The Deua NPWS Manager, Tony Baxter and a field worker from Braidwood were included in a preliminary investigation into the project to determine if the project was feasible. Tony has indicated strongly that if a club wants a permit to Wyanbene Cave and to include the restoration process as part of their permit then that will not be included in the 6 general permits that will be issued for that year under appendix 4 of the Deua KAMP.

We commenced some preliminary cleaning adjacent to Cleopatra's Bath area, the ladder pitch, in the Old Tourist section (OTS) and on Sunday in the Entrance streamway (ES).

The results have been more than satisfactory and the NPWS is writing a grant application for a pump, hose and signage with photos to be included in the OTS and ES to educate and encourage the public not to dirty the formation.

CSS and ISS will be the main proponents for the restoration work but we encourage other clubs that visit the area, to undertake a bit of cleaning on their journey through the cave and to minimise further mud contamination where ever possible.

We have placed a few small black mats on the mud section to assist entry and exit over the mud section near the ladder climb and have placed flagging tape around some formations that have been cleaned of mud in that chamber. There is also a path marked with flagging tape in the OTS for the moment to see how it goes until other track marking can be obtained. We would ask that the Cleopatra's Bath area be a boot removal area and/or dirty trog suit removed to reduce further impact on this area. We are working on ideas for the Helictite Chamber.

There will be some cleaning equipment left in the ladder chamber for use by groups. And other equipment that can be given to groups as they pass by say Pheasants' Nest for a Sunday clean-up in the Entrance streamway or OTS. This gear can be returned to Canberra or Wollongong or an arranged place.

More information will be given at the next NSW Speleo Council meeting in May 2013 but for the meantime if you are intending to obtain a permit for Wyanbene and want to assist us please contact:

John Brush (johnbrush@ozemail.com.au) or
Bob Kershaw (rkershaw@ozemail.com.au)

for further information.

MUSIC OF THE CAVES: Cultural significance of sandstone caves in the Sydney Basin

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Abstract

Small caves are found throughout the onshore Sydney Basin, but an inventory of over 1,200 has only recently been compiled for the database of the Australian Speleological Federation Inc. Many caves, particularly those in the Blue Mountains have cultural significance for both Aboriginal and European inhabitants. Aboriginal sites have been studied for a century, but only a few academic researchers have studied the development of the caves and karst features, a team formerly at Wollongong University being particularly prominent. Several examples are given of the cultural significance of cave sites: for music, poetry, history, bushwalking, rock-climbing, bouldering and canyoning. As a group, the caves are of importance mostly for their association with human activity. Their scientific significance is less but some contain unusual features such as silicate and other deposits worthy of proper management.

People and Landscape

The onshore 36,000km² Sydney Basin comprises some of the planet's most spectacular landscapes, including World Heritage Areas which, however, gained that status primarily for their natural biological values. Many caves are found in either the Middle Triassic Hawkesbury Sandstone, or the Early Triassic Narrabeen Group of massive sandstones interbedded with claystones and shale, with a few unusual block-gliding caves in the Nowra Sasndtone south of the Shoalhaven River. Beyond the Cumberland Plain of Sydney's metropolitan area, outcrops of the first are dominant over most of the coastal zone and from the Southern Highlands district to ridges north of the Hawkesbury River, while the latter predominate in the upper Blue Mountains west of Woodford.

Most caves in the Hawkesbury and Narrabeen sandstones are similar in form and at least partly solutional in origin. In the Narrabeen Group caves are commonly associated with knickpoints, waterfalls and intercalated beds of claystone, and at least 40 or 50 are found in deep, narrow and often quite dark canyons, which in some cases are no more than a metre wide at base. The paucity and lenticular nature of such beds in the Hawkesbury Sandstone produces few canyons but simpler and still numerous caves.

Caves are scattered widely throughout the region, most being small, but over 1,200 are recorded as greater than 3m in length in the database of the Australian Speleological Federation Inc., the longest being 263m (Dunkley, in press). Their density varies considerably, from less than one per 100km², up to 3-4 per km². Most are clustered low in the landscape, beside or on mid-slopes above watercourses, some in the middle of the Sydney metropolitan area. The higher, usually drier sandstone ridges have few caves. A quarter of the Basin is almost uninhabited national park and declared wilderness, yet over 800 caves lie within at most a 30-minute drive and 20 minutes walking distance of the population (nearly 6 million people) in the heavily urbanised Newcastle – Sydney - Wollongong conurbation. Indeed many are in valleys within the metropolitan area. Although mostly small and only occasionally serving as a specific destination, they receive a great number of visitors.

Aboriginal sites have been studied for a century, and although a few academic studies of karst and caves have occurred (Johnson 1974; Wray 1993, 1995; Young et al. 2009 inter alia), these features are consistently underappreciated and underestimated in cave and karst literature and by natural and cultural heritage managers, as well as by recreational cavers, the last perhaps because their speleological pedigree is not recognised. The inventory includes about 114 sea caves, 20+ block-gliding caves, 40+ in narrow, deep and often dark canyons, 30-40 with unusual iron and silica concretions, and 2 stream caves. In addition, at least 200 contain evidence of Aboriginal occupation; 45 have white historical associations; 25 were used for a period as homes, mainly by destitute people in the last century; 30+ are camping caves used by bushwalkers; 20 are connected with bushranger legends; 20 are used for rock climbing and bouldering; 14 inspired poetry, music or art, and at least 10 or 20 contain glow worm populations.

FIGURE 1. *Barralliers Cave, near Yerranderie, was used for shelter by Francis Barrallier during an attempt to cross the Blue Mountains in 1802*

Aboriginal significance of caves

The oldest of over 150 Aboriginal occupation cave sites dates back at least 22,000 years, and a further 100+ have been identified which, by location, size and aspect are potential aboriginal sites. Most of these are located at altitudes of less than 400m. For a century after white settlement, passing scientists just observed and described Aboriginal people and their customs, taking little interest in their cave sites and less in prehistory. Nearly a century passed before serious studies were undertaken of cave art sites and properly documented and scientifically executed excavations were undertaken. Even then, much of the work was undertaken by professional polymaths from other fields such as geology (Edgeworth David), palaeontology (Robert Etheridge) and surveying (R.H. Mathews), the last of whom apparently studied 50 caves and 70 rock art sites. In recent years Australian archaeology has been revolutionised by many more qualified archaeologists, and intensive studies have been undertaken in restricted areas in military reserves and water catchment areas, aiding site conservation. Attenbrow (2002) provided a comprehensive review and descriptions of sites open to the public. Important caves continue to be identified in remote areas of Wollemi and other national parks and there are undoubtedly many more awaiting rediscovery.

FIGURE 2. *Hangmans Cave WL478, near Wisemans Ferry*

European perspectives and perceptions

First Fleet settlers recorded Aboriginal life in caves around Sydney Harbour from the day they arrived in January 1788. A few caves gained historical significance when recorded during the first attempts to cross the Blue Mountains, in one case (Barralliers Cave) settling a long debate about an explorer's route in 1802 (Dunkley 2002). About 20 are named after known or alleged early bushrangers, or in connection with other illegal activity such as stills and stolen goods. There are, for example, no less than 5 Donohoes Caves, named for the "Bold Jack" Donohue of musical legend, stretching from Epping through Parramatta to the Nepean River, The Oaks and Picton.

A kilometre north of Wisemans Ferry, legend relates that Hangmans Cave was used to despatch convicts. There is no evidence of this; the cave was probably used to store explosives or shelter guards during construction of the first Great North Road to Newcastle, but it's a good story.

A similar distance south of Wisemans Ferry with a great view, Courthouse Cave carries a legend that sittings of the local court were held there before a proper building was erected, and the sandstone has certainly been cut to allow seating. Authorities have installed measures to prevent it collapsing on to the road below.

For nearly a century places such as Kings Cave at Linden housed military guards, road gangs, railway and other itiner-

ant builders and workers. Nearby are small caves used for storing supplies and explosives (not for prisons as sometimes stated).

Otherwise, during and after the convict era, for many years the sandstone around Sydney became country to be hurried across rather than settled.

Partly as the result of gold rushes, by the 1880s Australia was a wealthy country and railways began to deliver tourists to these wild landscapes. Over the next 50 years landowners, hotel entrepreneurs and local councils constructed walking tracks totalling 300km in length to pleasant sights (Smith 1999), including numerous small caves which in turn acquired romantic, fanciful and feminine names, and which appeared on postcards and souvenir books. Prime examples of names include Lovers Nook, True Lovers, Bride and Bridegroom, Honeymoon, various Fairies of indeterminate gender, a Mermaid, and one cave each for Annie, Eveline, Minnie, Maxine, Vera, Hilda, Alice Louisa, Claire and Marguerite. There's also a Wedlock but no Separation or Divorce Cave!

The Modern Era: walkers, adventurers and artists

The early reservation of sites such as Mermaids Cave at Blackheath in 1882 began a period during which, eventually, nearly all sandstone caves in the region would remain in public ownership. After 1935 many such sites were forgotten or neglected, but most trails have survived and many rehabilitated because the more rugged land became incorporated into public reserves and later national parks.

Often with constructed windbreaks and levelled floors, over 30 caves are known to have been used for bush camping by walkers and climbers, and most still are, especially in rugged country more than a day's walk from roads. Attic, Dadder and Word Caves in the Blue Labyrinth south of Glenbrook were early examples. Most, however, are found in the remote long-distance walking country south of Katoomba, extending from Narrow Neck to Kanangra Walls and further to the Kowmung River and Yerranderie. The largest such as Hundred Man and Thousand Man Caves reflect their capacity. Some caves (Darks, Walford, Rookery Nook and Professor Eds, along with several in Royal and Kuring-gai National Parks) were appropriated as weekend and holiday retreats by walkers, fishermen and others, and partly as a result have in-

FIGURE 3. *Pumping Station Cave WL681, Katoomba was a popular bushwalkers' camping cave*

spired works by writers, poets, artists and musicians. A number (including some sea caves) were used as permanent homes by recluses and the indigent around metropolitan Sydney, especially in the early 20th century and during depression years. As recently as 2011 inhabitants of several caves in Royal National Park on the southern outskirts of the city were removed by authorities.

In recent decades the sports of bouldering, rock-climbing, and canyoning have flourished throughout the region, the first mostly in the metropolitan area, the other two especially

FIGURE 4. *A small bouldering cave near North Rocks*

in the upper Blue Mountains, where at least 20 caves are used by climbers, some with fixed routes. Commercial operators are active at Blackheath, Mt Boyce and especially at Mt York where a well-built stairway accessing climbing caves was built mainly from commercial donations. Caves in the splendid deep and narrow canyons are less frequented and more robust because of regular flooding, but several are photographically spectacular and a number have lengthy dark sections. Some are utilised for training by cavers.

A few such as Lourdes Grotto near Springwood have religious and spiritual connections, and quite a number have proved to be the last living spaces of both white and black people. Others have been inspirational to artists, poets, writers and musicians.

While living in Lithgow, Henry Lawson wrote a little poetry entitled “On the Summit of Mt Clarence” about a hermit living in a cave there.

In a cave among the ridges,
where the scrub is tall and thick,
with no human being near near him,
dwells a wretched lunatic ...

There is a Henry Lawson Cave in suburban Sydney, in Willoughby, with small tiered seating outside the cave where occasional readings of his and other poetry is held.

In 1929 F.C.Meyer wrote a dozen pieces of doggerel celebrating caves at Jenolan and in the Blue Mountains, including Coxs, York, Hildas Grotto, Lyre Bird Dell, Walls, Ross, Bushrangers and Engineers Cascade Caves. The European heritage of Emu Cave on the Bell Road has also enjoyed some unremarkable poetry, but something better was penned about Baiame and Bull Caves.

In the 1940s author Eleanor Dark formed a Music Club for local residents starved of good music, arranging for performers from the Sydney Conservatorium to visit. Some may have been performed in Darks Cave, which is fairly remote, and it is there also that she apparently wrote parts of her trilogy “The Timeless Land”, a best-seller in 1950s Australia. This cave was also a kind of spiritual home for adventure activities in the district, for Eric Dark was an avid outdoors enthusiast

FIGURE 5. *Henry Lawson Cave WL115, in Willoughby, used for occasional poetry readings*

who pioneered the sport of rock-climbing in the Blue Mountains. Local legend was that in World War 2, the Darks were provisioning their cave against a Japanese invasion (they actually were in civil defence), and in the McCarthyist era some thought they were closet communists.

It was certainly from numerous visits here that a close friend of the Darks and one who clearly shared their humanistic philosophy and love of the outdoors, received much of his artistic inspiration. Much later in life, in 1999 William Holland composed his descriptive music for Darks Cave, the first public playing of a recording of which occurred at the ASF Conference at Galong in 2013. Scored for soprano, bass baritone, piano, choir and orchestra, it has three thematic movements: ‘Nature and the Aborigines’, ‘Katoomba’, and ‘The Cave’.

Darks Cave is a shelter and a refuge – quiet place to think
Far away from distractions and pressures – to newly look at life
While there are many such caves – they are sometimes hard to find
Other things too, like music and words can refresh and the spirit renews

In 2004 Holland went on to compose ‘Walls Cave’, a one-movement, 11m40s piece for orchestra.

Overall, the most frequently visited caves are in the upper Blue Mountains, from Wentworth Falls to Lithgow and Newnes. It appears possible that, however fleetingly, more people

visit the sandstone caves in the Sydney and Blue Mountains Region than all the state's show caves combined.

Significance, Conservation and Management

Most caves are quite robust and have survived well, some having been used by humans for thousands of years, although evidence is that Aboriginal occupation did hasten deterioration of caves and art sites. Their location in the more rugged terrain along and on the steep slopes above water courses rather than on ridge tops also contributed to survival. Intensive research has concentrated on Aboriginal sites, such as that relating to survival of cave art sites (Hughes 1978). Many sensitive Aboriginal sites are protected primarily by lack of publicity and/or by their location in military and water catchment or remote and rugged areas; however a few close to urban settlement have suffered inexcusable vandalism. Some protective measures are now in place. Caves with aesthetically pleasing, thin protruding bedrock plates are vulnerable, and no additional protective measures have been provided; the same applies to those with unusual or rare mineral depositions. The greatest environmental pressure comes from urban development which has concentrated run-off and thus flooding, sedimentation, pollution, infiltration of garden and other chemicals, and has increased graffiti. Although improvements have occurred in the last few years, geoheritage has not rated highly in the priorities of public management authorities, and important landscapes such as those of Gardens of Stone National Park have not been adequately studied.

The European heritage of these caves has been little appreciated, and evidence is retained largely through historical and a few heritage studies. The caves are worth celebrating primarily for their association with human life and endeavour, in other words, for their intangible cultural and heritage value. Their scientific significance is less although some contain unusual features and deposits worthy of further research and proper conservation measures.

Their location in National Parks diminishes the likelihood of maintaining links with their European heritage, and in time perhaps little will remain to remind us beyond some music, poetry, some old books and reports, and a few interpretation signs.

Acknowledgments

The author has documented sandstone caves for over 40 years and not all assistance can be listed here. Recent field work was greatly assisted by members of Highland Caving Group, and advice on documentation procedures was provided by Peter Dykes. This paper is condensed from a longer book in press, the content of which benefitted from critical comments by Dr Susan White, Latrobe University, Melbourne, and by Cathy Brown, Geoscience Australia, Canberra.

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Investigating rare microbial communities of the Nullarbor Plain

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The Nullarbor Plain is located in the South-West of Australia and forms the onshore region of the Eucla basin, one of the world's largest karst areas. The region contains many flooded features, filled with brackish water; however, relatively few of the flooded caves have been explored and even fewer have been the subject of published, aquatic ecological investigations. Observations made during previous phylogenetic research indicated the microbial communities found within the caves, may have limited re-growth and be vulnerable to disturbance by cave diving activities. In response to this anecdotal information, a systematic study commenced in 2010 and is centred on the microbial communities of 5 Nullarbor caves (Murra El Elevyn, Warbla, Weebubbie, Olwolgin and Burnabbie). The study includes growth, spatial distribution and photographing unique forms of the bacterial communities within the caves. Growth is being investigated by obtaining regular measurements from 9 sites within Murra El Elevyn cave and also from 10 sites within Warbla cave. Murra El Elevyn is a popular dive site, whereas Warbla is a reference cave and therefore is not subjected to the same level of visitation by divers. Along with obtaining growth information, it is anticipated the comparison of data from these caves will provide insight into the effect of diving upon bacterial growth. Spatial distribution patterns are being identified by using modified quadrat and visual counting methods. Although the bacterial communities have two generic forms, a hanging mantle and a supine mat form, it has become evident that there is a considerable amount of variation within these broad types. A unique mantle form observed within Olwolgin cave, appears to have a central core within a gelatinous outer coat, giving the impression that it is not a bacterial community - when in fact, it is. These communities are no more than 15 cm in length and are quite small in diameter. Several mat communities within Burnabbie cave have developed in a conical shape because they are growing upon a conically shaped silt pile. However, it is not evident why the silt or the bacteria have assumed this shape. The ongoing cataloguing of unique features will continue in conjunction with growth and distribution investigations until mid-2013, when the data will be analysed and the results published.

2

Presentations

Keynote: Recent developments in cave and karst science

Armstrong Osborne
University of Sydney

The collapse of the Soviet bloc and the emergence of democratic governance in central Europe in the 1990s promoted the development of new ideas in the traditional homes of cave science. Coupled with better communication and ease of international collaboration this made the late 1990s and makes the early 21st century an exciting time in cave and karst science. I will illustrate these developments with reference to seven areas of change and controversy, four (2,3,4 & 5) are directly relevant to eastern Australian caves and two (6 & 7) may be relevant to studies of sandstone landforms in the Sydney Basin.

1. Polje were long regarded as solutional karst landforms. During the 1990s some Slovenians suggested that these were principally tectonic features, which sure got the Yanks upset.

2. The recognition and study of unroofed caves. The great Cvijić and the old geography texts were wrong, and there was karst in the past and stalagmites can outlast the caves they formed in.

3. Detailed study of caves: this may sound strange, but it was only in the 1990s that people started to study caves in significant detail, or *look up*! The results have been dramatic.

4. The hydrogene (or per ascentum) revolution: the traditional view is that caves form by surface water sinking into the rock. From about 1996 the idea that caves can form from the bottom up became popular and remains controversial. This explains a lot of what we see in eastern Australian caves, many of which have no fluvial features and are isolated from the surface hydrology.

5. The recognition of ancient cave sediments and ancient caves, not palaeokarst, but accessible caves surviving for hundreds of millions of years. This is quite a radical idea, but cave sediments millions of years old are now being identified in Europe and we have Carboniferous cave sediments at Jenolan.

6. Phantom or ghost rock, the recognition that internal weathering fronts may mimic the shape of caves so that when the weathered material is removed a cave is left behind emerged in Belgium in the late 1990s. This strange idea is applicable to caves in impure carbonates and non carbonate rocks.

7. Martian bacteria: NASA is funding work on “extremophile” bacteria in caves. This work is not only important for extra-terrestrial life, the bugs are up to other things in caves on Earth and all is not what it seems.

Cave palaeontology in the 21st century: unearthing our underground biodiversity records to help preserve our future

Julien Louys

Vertebrate Palaeocology Research Group, School of Earth Sciences, University of Queensland

Fossils preserved in caves have long been renowned for the spectacular glimpses of the past that they provide to the general public, technical enthusiasts and scientific professionals. Although these deposits are sometimes quite difficult to access, the material that can be recovered from caves is unparalleled. In particular, palaeontologists value cave fossils because of their often great level of preservation, completeness and the abundance of material preserved and available to study. These qualities in particular are essential for palaeoecologists - those scientists with an interest in determining ancient environments and their effects on both living and extinct animals. Such insights are critical to determining how communities and ecosystems have reacted to climate change in the past, and allow us to build realistic models of how future climate change might affect the biodiversity upon which we currently rely. This presentation will showcase some recently explored and excavated caves that have yielded abundant fossil material, and how this information can be interpreted to provide information critical to modern conservation efforts.

http://nswsc.caves.org.au/trogalong/video/Cave-palaeontology_Julien_Louys.avi

The world's first cavers: dating the associations between man and caves over 3 million years of human history in South Africa

Andy Herries

Head of Archeaomagnetism Laboratory, Archaeology Program, LaTrobe University

The association between our early ancestors and caves is so strong that when many people think of our earliest relatives they most likely think of the term 'caveman'. Be it 'walking with cavemen' or 'Captain Caveman' this image permeates our consciousness and society. But when did humans first utilise caves and why? and how has our use of caves changed over time? Human fossils are found in caves as long ago as 3 million years in northern South Africa, when we were little more than bipedal apes. Debates have raged over whether these early humans were living in the caves and eating the other animals that are found there, or whether humans were little more than the hunted themselves. This talk will explore the question of how caves have shaped our evolutionary history. From the dolomite Highveld caves of Gauteng Province to the coastal quartzite caves along the southern Cape coast, where groups of early humans struggling against the forces of nature first learnt to exploit the sea; perhaps even saving us from extinction some 200–150,000 years ago. Determining the age of many of these cave deposits has proven difficult and the talk will also focus on how new methods have been developed to date these ancient caves and how such methods are now being used to date marsupial fossil sites in Australia, like those at Wellington Caves in NSW.

Salt caves of the Atacama Desert, Northern Chile or Is it time for another pisco sour?

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Extended Abstract

Chile is not noted for its caves. It's very big on coastlines, copper mines and the national drink, pisco sour. There are sea caves near Arica, close to the Peruvian border, while in Chilean Patagonia there are a few in conglomerate near Torres del Paine in Chilean Patagonia, and some archaeologically significant and other physically demanding caves in marble on the cold, desolate and windswept Isla Madre de Dios in the far south. In the Atacama Desert there are caves in rock salt near the small, World Heritage listed Atacameño (indigenous) town of San Pedro de Atacama.

The Atacama is the driest place in the world, and some villages have apparently not recorded rain since the Spanish arrived 500 years ago. San Pedro boasts a highly variable average of 0.4mm/pa. In an enclosed basin (Salar de Atacama) with stunning scenery dominated by Licancabur volcano (5,940m), it is an oasis watered and occasionally flooded by snow-melt and run-off from the main cordillera of the Andes.

At an elevation of 2,450 – 2500m, karst is widespread in the Salar de Atacama but exploration is restricted by rugged terrain, rough and/or sandy roads, and sharp karren. There have been two or three small French and one or two American expeditions, the latter financed by NASA grants ostensibly to study cave parameters that might inform exploration of similar terrain on Mars. Similar terrains exist elsewhere in northern Chile with very limited exploration to date.

The great rainfall variability results in cave initiation and enlargement being highly concentrated following the rare occasions of heavy rain, and the French expeditions estimated that some caves had been excavated in only 5,000 years. The halite is of variable purity, ranging from 50 to over 97% NaCl, most of the remainder being clay.

Chulacao Cave is occasionally used as a guided adventure cave by Chilean National Parks (CONAF). From three steep doline entrances in two branches below the main road to Calama, walking passages 1-2m wide and 3-6m high 3-4m pass south through a ridge, emerging on the floor of the main valley of Salar de Atacama. Neither the Americans nor our own small team confirmed whether it can be entered at the southern end where the passage is very low. The cave floor is encrusted with salt over its whole length and there are a few tumbled boulders in a higher level at the largest entrance.

Cueva de Sal (Salt Cave) is a self-guided tourist cave about 9km SW of the town in Valle de la Luna (Moon Valley), which is probably the single biggest tourist attraction in the region. Beginning 50m up a dry wadi north of the road, a narrow meandering canyon (clearly discernible on GoogleEarth) is discontinuously roofed over for about half its length of .about 400m, with the return walk being over the karst. The longest single cave is 70m and a torch is handy. There are a couple of smaller caves further up the dry stream bed beyond Cueva de Sal. The park's visitor centre features an excellent interpretation of the karst and the caves.

Other known caves include Cueva de Quitor (68m), a short tourist cave north of San Pedro, and Reseau de l'Election (Election Cave). Explored by a French team, this is of similar dimensions to Cueva de Sal, segmented into 15 roofed caves 1-2m high and 1.5-3m wide. Total passage length is 130m in a shallow canyon 483m long. Chulacao & Salt Caves were surveyed by the author and Dick Heffernan in 2012, but due to the flooded river we were unable to investigate possible similar features identified from GoogleEarth, east of a side road 3km north of San Pedro.

Other caves in rock salt are found in Roumania, Spain, Iran and Israel. The world's longest such cave is probably the well decorated Namakdan Cave, on Qeshm Island in the Strait of Hormuz, Persian Gulf, Iran.

Trekking to Chulacao Cave

Salt-encrusted stream bed in Chulacao Cave

Doline near Chulacao Cave

Karren at an entrance to Cueva de Sal

Low section, Cueva de Sal

Another entrance near Cueva de Sal

Typical passage, Cueva de Sal

3

Workshops

Fishy recipes for volunteering

Fiona Ferguson

Manager, Age of Fishes Museum - Canowindra, NSW

Fiona Ferguson provided a presentation on the policy, management, health and safety, and human resources issues that he has encountered as manager of a substantial volunteer organisation.

Wyanbene cave rehabilitation and GIS workshop

Robert Kershaw

Illawarra Speleological Society

Illawarra Speleological Society is using the ASF sponsored ESRI ARCmap to keep track of the sites cleaned in Wyanbene Cave along with photographs of pre and post cleaned areas. This workshop shows the cleaning items (brushes and collapsible back pack spray) and the GIS process from the development of the data, maintaining and producing maps and reports for NPWS and ASF, that are both assisting in this project.

Conversion of printed club journals to electronic storage, and specifications for electronic publishing

Bruce Welch

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Choice of Scanner

Most scanners would be suitable for scanning club records, this includes journals and photographs. The problems arise with ensuring that you scan once so that the scans can be used for a range of purposes. There is little point in scanning journals without the resolution and format being suitable for Optical Character Recognition (OCR). Similarly, it is a wast of time scanning photographs and slides at low resolution for web viewing; it is much better to scan initially at high resolution and then, if necessary, make copies of the scans and reduce the resolution for web etc.

If journals or books are bound it is often difficult to get a good result without destroying the journal or book. I have a Plustek OpticBook A300 which is an A3 scanner where the glass and scanning head goes right to the edge along one side. This allows a book or journal to be scanned without breaking the spine.

The optics and software on this scanner allow for superb results. The usual method is to scan to a multiple-page PDF which has a high resolution (600ppi) JPG image behind each page. These images can be edited by opening the PDF file in Adobe Acrobat Pro and then opening the page within Adobe Photoshop. The normal editing is usually to clean up any stray marks and perhaps to repair some broken type.

Loose-leaf scanning is easier, especially if you have access to an automatic-feed double-sided scanner. Don't forget that for good OCR the scanning must be at 600ppi.

There are scanning systems which use one or two digital cameras to photograph each page of a document, however the quality of the scan is sometimes not suitable for OCR.

Reflective scanning is used for books, journals, photographic prints etc, while transmission scanning is used for slides and glass plates.

In the end, you get what you pay for in a scanner. An expensive scanner (mine cost $2000) has good optics, good software and good hardware.

To scan a book or journal which contains photographs, the images will have to be scanned separately (either as greyscale or colour) at 300ppi, descreened in Photoshop (or similar) and then placed back into the PDF using Adobe Acrobat Professional.

Again, Acrobat has the best OCR software, other programs may be OK but I cannot vouch for any of them. Sometimes pages are rotated (from portrait to landscape) during the OCR process, in which case rotate them back again and save the file.

Storage & Hosting

Once you have scanned your valuable records make sure that you store them on a number of different mediums and in different locations. Storage options range from CDs & DVDs, external hard drives and hosting on fileservers. Remember that CDs & DVDs are not archival and external hard drives can fail. Solid state storage is becoming cheaper but there are still reliability issues. The Linnean Society of NSW is now having all its back issues hosted on the University of Sydney Library eScholarship website (back issues are at http://ojs-prod.library.usyd.edu.au/index.php/LIN/issue/archive, the current issue is at http://ojs-prod.library.usyd.edu.au/index.php/LIN/index and all the different organisations are at http://ojs-prod.library.usyd.edu.au/). I consider this to be one of the best options for permanent storage of your files as they are properly backed up.

You can have the files also on your own club web site and you can create a CD/DVD for distribution to members. The ASF is doing a DVD of all the Conference Proceedings which will be available soon. This DVD will also have on it a combined contents of all the proceedings so that this one file can be

searched quickly for any keyword(s) such as the author's name, subject or even just a cave name. Naturally it is possible search every PDF file on the DVD using search "All PDF Documents in" and select the appropriate folder.

Do not throw away the journals once you have scanned them. If you don't want to store them make sure they go to a library such as the National Library, Mitchell Library, State Library of Victoria etc. Give them a copy of the digital files too.

Converting files to HTML is not really a good idea as it is hard to extract the text and all the images are drastically down-sampled. ePub files are OK for novels but I consider them a waste of time for most caving related files. High-resolution PDFs, TIFFs and Word are likely to be readable for a very long time.

Scanning Images for Archiving

The museum standard for photographs is 300ppi at A4 size (or 10" x 8" if that is what the print size is). Postcards should be scanned at 300ppi at 200% size (or 600ppi at same-size); smaller prints should be scanned at 300ppi at 400% size (or 1200ppi at same-size); slides should be scanned at 300ppi at 800% size (or 2400ppi at same-size) however in all cases scan at higher resolution if you can. Scan all photographs in colour even if they are "black & white" as this will better capture the full tonal range.

Save all images as TIFF files as this is a lossless format. If required you can save a copy at a lower resolution as a JPG file for emailing. Unless absolutely necessary, do not use your scanner software to manipulate the file as scanner software is often very poor, it is always best to do this in a proper program such as Photoshop.

Storage of your files is the same as for your journals although Flickr is very good and a lot of libraries and museums use it. I have put up about 300 images for the Jenolan Caves Historical & Preservation Society – see
http://www.flickr.com/photos/jenolan_history/

Microsoft Word Rules

Ignore these Word rules at your peril!

- Don't do double returns between paragraphs
- Don't double-space after sentences
- Don't use multiple tabs to space or align
- Don't use multiple columns
- Don't use manual page breaks
- Don't place photos or graphs in Word
- Don't try complex formatting
- Don't make a number of files into one file
- Use paragraph styles if you know how
- Turn Paragraph marks on
- Word set-up for PDF creation
- Do not use Printer Metrics to lay out your document
- Do not allow A4/Letter resizing
- Embed ALL fonts
- Check that there is NO font substitution

Which software to use for creating a PDF from Word

My preferred program is PDF Creator which is a free program. It is important to change the <Options><PDF> to "Prepress". When installed, PDF Creator sets up a "virtual printer" in with your other printers, this also happens when you install Adobe Acrobat Professional. In Word (or any other program) go to <File><Print...> and select one of these virtual printers. If you use the Adobe PDF printer, make sure that you select "Press Quality". With these setting both will create a file which will not adversely down-sample the file and will ensure that all fonts are embedded.

Once you have created your PDF file it is very important to check it. The best way to do this is to print it out and make sure that nothing has changed from your original Word file.

Specifications for Electronic Publishing

Always supply images as TIFF files. If for some reason this is not possible, make sure that when the file is saved as a JPG that you select "Quality 12 Maximum large file" otherwise the file will be degraded. Images must be 300ppi (or larger) at the size that they are to be reproduced. Never supply images in a Word document as this may reduce their resolution and these images are very difficult to extract from a Word file. Similarly, supply Excel files separately, either as xls/xlsx or as a PDF (created using PDF Creator or Adobe Acrobat).

Line drawings and line art should be scanned at 1200ppi (minimum 600ppi) but not as greyscale or colour; your scanner will use terms such as line, text, black & white, bitmap. Vector files (ie files created in Corel Draw, Adobe Illustrator etc) should be supplied as EPS or PDF files with the fonts embedded.

Remember an original is NOT . . .

- A print from a slide
- Colour or black & white copies of a print, drawing or previously offset printed image
- Colour or black & white print-out of a scan
- An image taken from the web
- A file from your camera that has been opened & resaved on your computer as a JPG, and/or emailed

An original is . . .

- A first generation slide,
- a print (from a negative) or a drawing
- A file transferred from your digital camera (and not opened & resaved)
- A previously offset printed image

PPI; LPI; DPI; SPI

dpi* = dots per inch* ~ (e.g. scan @ 300 dpi)

spi = samples (spots) per inch (e.g. scan @ 300 dpi)

ppi = pixels per inch ~ held in computer

lpi = lines per inch ~ screen ruling applied

dpi = dots per inch ~ output imagesetter or digital printer

* some scanning software refers to dpi when they really mean spi and/or ppi

Some Tips for the use of Adobe Programs

InDesign

Life will be a lot easier for you if you customise the Preferences to show “Custom Tracking/Kerning” <Edit><Preferences><Composition>. You should also “Show Hidden Characters” <Type><Show Hidden Characters>. This will allow you to see how many spaces there are between each word, where the tab marks are, and where the paragraph marks are. This is particularly important in troubleshooting text that has been imported from Word. You also might like to colourise your menus <Edit><Menus...>.

Use paragraph styles and if you wish to import a multi-page PDF use the freely available script. Be careful with colour, it is important that all swatches are CMYK and that there are no RGB swatches. To simplify your file remove all unused swatches except C,M,Y & K. Set up a custom “Preflight Profile” so that InDesign is constantly checking for low resolution images, RGB colourspace, etc.

One good tip if you are having trouble with Word text is to copy and paste it into Notepad, then copy and paste it into InDesign. This will strip out all hidden formatting, however be careful as this method will not retain italics. In fact pasting any text into InDesign will behave in the same way. Place all images and text using <File><Place> (Ctrl D), never paste or drag images as this will cause problems further down the track.

Once you have finished your job in InDesign package the file <File><Package>, then close the current InDesign file. The reason for packaging the file is that by so doing, InDesign will check all the links, create a new folder called “Links” and collect all the linked files into this folder. InDesign will also create a folder called “Fonts” and collect a copy of all the fonts used in your document into this folder. The new master folder that InDesign has created (which contains a copy of the InDesign file, plus the Links folder, plus the Fonts folder) is the one that you should archive.

To create your high-resolution PDF file navigate to the new InDesign file and open it. Then go to <File><Export> and make sure that the “Save as type” is set to “Adobe PDF (print)”. Use the “Adobe

PDF Preset” called [Press Quality] and under “Marks and Bleeds” tick “Crop Marks”, set the “Offset” to 5mm and tick “Use Document Bleed Settings” which should be 5mm. Once you have created your PDF file pre-flight it (see the Acrobat section of this paper for details).

Photoshop

The use of Photoshop is enhanced with the use of menu colours, go to <Edit><Menus...> and select the colourisations you like for the frequently used or difficult to remember menu items, for example I always colourise “Image – Mode - CMYK”. One semi-hidden item is the expanded options in “Shadows/Highlights” <Image><Adjustments><Shadows/Highlights>. Make sure the “Show More Options” box is ticked, then set the “Shadows” to 0-30-30; the “Highlights” to 0-30-30; the “Adjustments” to 0-0 and then click “Save as Defaults” By doing this you will ensure that every time you use this tool it will open without any adjustment to your image, and by sliding the Shadow-Amount; Highlight-Amount and the Midtone Contrast (with “Preview” ticked) you will see the effect of these adjustments.

If you are new to Photoshop CS6 you will like the new straightening tool; this is available when you have the Crop tool selected.

Most scans and many photographs require a little “Unsharp Mask”. To de-screen an image that has been scanned from a previously printed image, use “Gaussian Blur” and then “Unsharp Mask”.

Acrobat

Unfortunately Acrobat X (contained in CS6) hides some of the previously easy-to-find menu items. The functions to reduce the size of a PDF, export to Word, export to postscript etc now appear under <File><Save As...>. The ability to combine a number of PDF files into a single PDF is now most easily accessed by closing the active PDF document (but not the program) and using the menu item which appears on the screen. I also find the functionality of Acrobat is greatly enhanced by customising the menu bar at the top of the screen. To this I add Rotate, Insert from File, Crop, Edit Document Text, Edit Object, In This File (OCR), Encrypt, Export All Images, Output Preview, Preflight, and Advanced Search.

You can use the default “Preflight” profiles, however you should set up your own, particularly for mono (black only) work. Most printing companies will supply you with their own preflight profile(s) which you can import straight into Acrobat.

Once you have created your PDF file using Acrobat you must check it. The first thing to do is to “Preflight” the file (using the button you put on the Menu Bar). If Preflight has been set up properly it will tell you about RGB in colour and mono jobs, more than one colour in a mono job, missing fonts, images and line art below the minimum standard, etc. You can also check the “Output Preview” to have a look at the colour separations. Once all this is done, make any corrections and re-PDF the file if required, and then print the document out and check it carefully.

Sometimes a problem PDF file that you have received from someone else can be fixed by saving it as a postscript file (.ps) and then recreated with Acrobat Distiller (using the correct settings of course).

Remember also that PDF files can be opened and edited in Illustrator.

Colour and Screens

The human eye can see a much wider range of colours than can be displayed on a computer screen (which uses RGB) – this range is called colour gamut. The process printing (CMYK) represents an even smaller range of colours.

RGB stands for Red Green Blue and when used on a computer screen full intensities of Red, Green and Blue give white – this is called additive colour. The opposite is true with CMYK (Cyan Magenta Yellow Black) where full intensities of CMY give black – this is called subtractive colour. In colour theory just CMY would be a true black, however technical limitations mean that a black printing plate is also added to give depth to the colour.

Because your computer screen can only give an approximation of the actual colours which are in your file (and also because most desktop printers also cannot properly represent the file) it is important to calibrate your monitor. The method of doing this depends on the operating system and the type of monitor you have. It is a common trap for people to alter colours on an uncalibrated monitor and then to be very disappointed when the final book comes back from the printer. This problem applies to mono photographs also. If in doubt get a commercial proof done.

Moiré

When a previously printed image is scanned and used in another publication a moiré pattern will appear. Unless you correct this before the job goes to the printer, you will have no idea how bad it might be. It is caused because the halftone screen applied by your printer clashes with the screen in the original image, how bad this clash is depends on the screen ruling and the screen angle of both. To get around this problem you must descreen the image – this is done in Photoshop by applying Gaussian Blur (at a level where the dot stops being visible) and then applying Unsharp Mask to bring the image back to look fairly close in sharpness to the what you started out with. Again how much you have to apply of each of these depends on the screen ruling (number of dots per inch) of the original.

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Workshop on Auriga and electronic cave surveying

Al Warild

Auriga is a freeware cave surveying package for PDAs running PalmOS, developed by Luc Le Blanc. It was developed for in-cave use, and provides bi-directional data exchange with Compass, Therion, Survex, TopoRobot, VisualTopo and Walls. It also supports Bluetooth communication with the DistoX.

Al presented a demonstration of the features of Auriga and a practical session.

Further information: http://www.speleo.qc.ca/auriga/

Overview of the CEGSA digital database focusing on the Articles data set

Graham Pilkington

Cave Exploration Group of South Australia

The CEGSA digital database is an attempt to have all of our data available at call. It has a hierarchical index overview into relational subsets. The current data covers library items such as journal and book holdings, management items such as membership and meetings, and karst records information.

To enable many people to contribute, the database is grouped into subsets, each of which can operate as an independent database.

The articles database handles references to articles of all types. Currently this is limited to newspapers and magazines, caving journals, and trip reports, but it's intended to include any document that can be referenced. Each type of reference data is itself a subset of the Articles database, and can be operated independently, but needs a special merge to realign into the main dataset. In keeping with the CEGSA database concept, not only is there a detailed index of each article, but the actual article can be displayed.

Preamble.

This workshop is presented to encourage other clubs to digitize their own Records and Library. It can be used as an aid in developing your own system. Copies of the software can be made available on request adjusted to your own club.

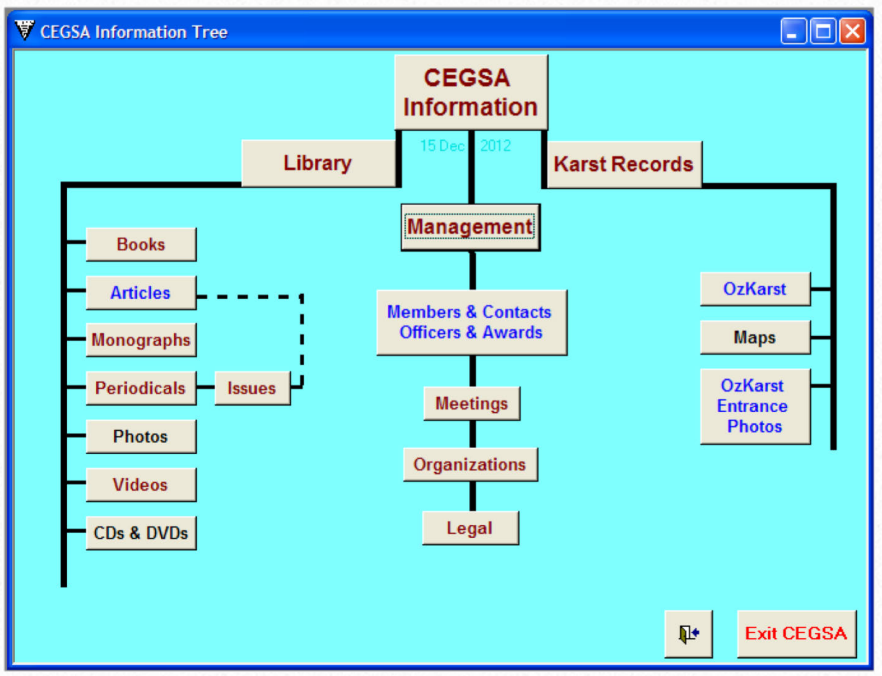
The CEGSA database began as a means of listing what we physically had in our Library and Records. It was a simple index and organized around the type on media being stored. For example, books, journals, maps, photographic slides and stills, videos, and "cave master sheets". When digitised information became more prevalent and the decision to make the actual data available in digital format, it became apparent that the media on which the data are stored is only relevant because of the quality implied.

As an example, photographs were first stored as prints, negatives, and slides and needed to be indexed accordingly. Photos can also come as digital images; scanned images; included in a report, journal or book; on hard drives, CD's, DVDs or Videos. Note the mixture of media and source. Data requests are rarely for a specific media but for the content – such as photo taken inside a specific cave. It was decided to ignore the media and convert the CEGSA database into a contents index and full retrieval system.

The following is a description of what we have – a mixture of media and content – as the database is slowly converted from a media index to content retrieval.

The CEGSA digital database.

The CEGSA digital database is an attempt to have all of our data available at call. It has a hierarchical index overview into relational subsets. It's written in the relational database software Microsoft ACCESS. The start-up screen is as follows:



To put everything into digital format is not only too great a task for one person, but the data are required to be up-to-date for specific Club Officers. CEGSA has implemented this by having independent databases linked to a central core so that officers can control the data subset appropriate to their function in the Group. On replying to requests, the officer is only responsible for their own data, linking in any other data required from the latest data subsets that they hold.

Currently the subsets that we have are:

Library & Records as the central focal database. Journal, book, CD and map holdings. Currently includes group management such as meetings and minutes.

People, including membership, office bearers, awards, and contacts.

OzKarst for all karst data, where each caving area can be controlled by a different person.

Articles, where each article data subset can be controlled by a different person (Newspapers and Magazines; Caving Journals; Trip Reports; ..)

Our data are divided into three logical sections:

Management items to do with running the club,

Karst Records to store data pertaining to caves and karst, and

Library to store published material.

In the data tree shown above, buttons with brown text indicate that the data is held in the core database and looked after by the Records Keeper. Buttons with blue text indicate that the data are held in an independent database, and buttons with black text indicate that the data group is still in preparation. It should be noted that that *Articles* database will be absorbing *Monographs* and probably *Books* as well.

Management This displays a list of the type of data stored under Management.

Meetings This displays a list of meetings that have been held by CEGSA.

The availability tick boxes are for:

- is known to exist,
- an image present – typically for hand-written (sometimes illegible!) minutes,
- digital text present.

The attendance column notes how many people were present. Double-clicking in this column brings up a list of the actual attendees. The names are extracted from the linked *Members & Contacts* database.

Double-clicking in the “for” column displays the actual minutes.

A secondary window appears that allows a restriction on the type of meetings displayed. This selection is stored for future use.

Organizations This brings up a Form displaying a selectable organization that either has an interaction with CEGSA or from which information has been obtained. This table is being expanded and united with the organization tables in all the separate databases.

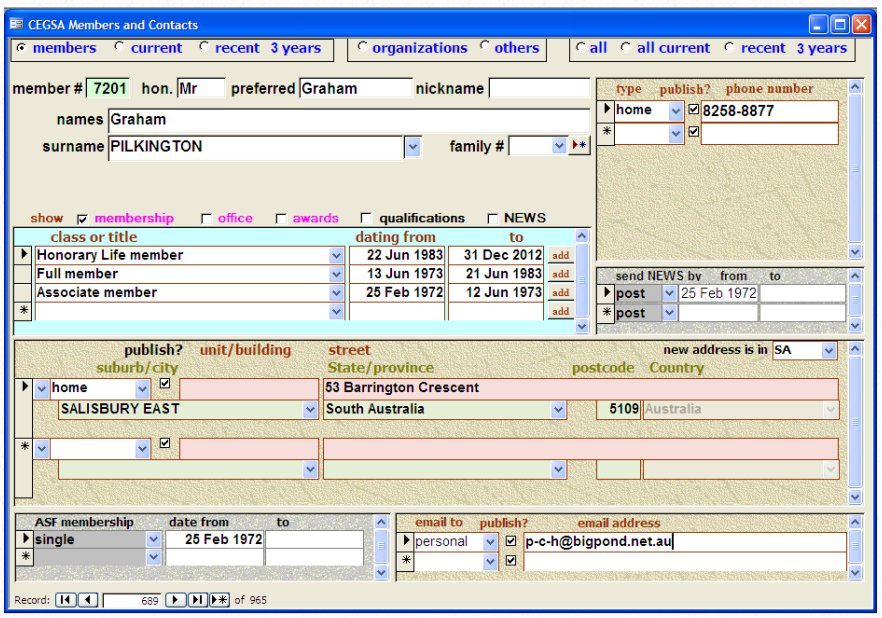
The “predec” box stores the organization from which this organization originated. Originally this was to cater for clubs that change their name but it needs to be expanded so that merged organizations such as the Southern Tasmanian Caverneers can show all the source clubs.

The “parent” box stores the organization that oversees this one. For example, the State Liaison Councils of the ASF would have the ASF as the parent.

Most of the started and ceased dates are missing because little research has been done on this. Similarly with the ASF 3-letter code.

Legal This brings up a Form displaying a selectable legal document such as our Constitution. Because we have so few documents currently entered and it is very infrequently used, the Form is in a primitive state. For instance, you need to scroll through all the available documents to find what you want. Clicking on Display retrieves the document.

Members & Contacts / Officers & Awards This brings up the database maintained by our Membership Officer. Naturally it’s designed to suit the way that CEGSA operates. The “publish?” tick boxes enable a very detailed selection of what information is allowed to be distributed. A full history is kept of membership status and addresses but most other fields are overwritten when updated. Note that historical data before the start date of this database has not always been



Membership and contacts page

completed for superseded or now irrelevant information; eg the ASF membership history.

Family memberships can be handled, including historical memberships. Each family membership has a "prime" member just for convenience in handling the members within the family.

Membership status can be selective to show any of membership/office/awards/qualifications. If data are available for a specific status class, then it's highlighted in colour.

Personal details can be accessed by double-clicking the names box. This shows any change in name such as when a member gets married. Without this, it can be confusing reading such things as trip reports. [Close *Details* box then select Ann Pilkington] Because she had two names, this is noted on the main form.

Karst Records This displays a list of the type of data stored under Karst Records. *This section is handled by OzKarst and will be covered in the next session.*

Library This displays a list of the type of data stored under Library.

Books Our books.

Monographs Our monographs. Note that this will be moved into the Articles database.

Videos Our videos. These will be merged with DVDs, CDs, and other media into the data type. For instance, movies, stills, documents, and data.

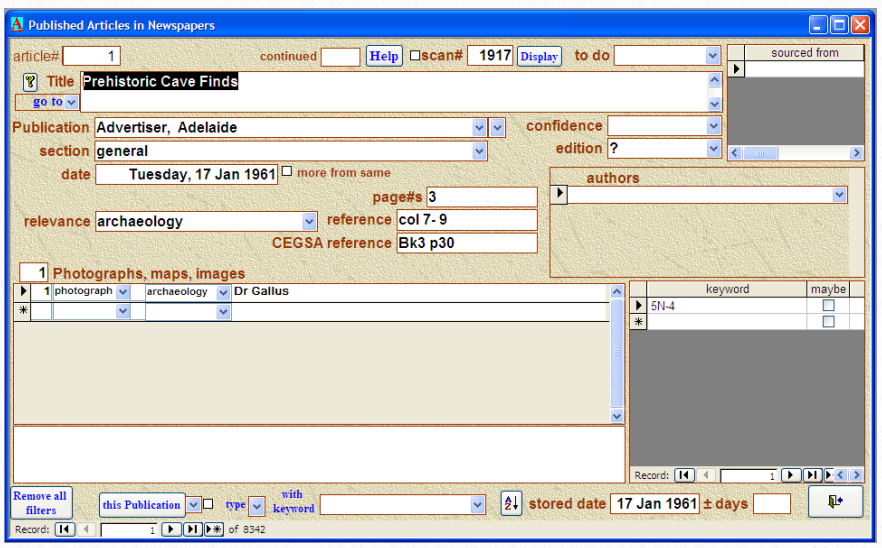
Periodicals A list of the periodicals held. The overlap with the *Articles* database is being sorted out.

Catalogued This is a tabulation of the issues of the periodicals. Some issues are available for display.

Clicking on a list brings up a quick summery for each issue, including what is bound into specific CEGSA hard covers.

Adding a new issue is largely automated.

Articles This brings up the *Articles* database. It's intended to include any document that can be referenced. Each type of reference data is a subset of the Articles database and can be operated independently but needs a special merge to realign into the main dataset. In keeping with the CEGSA database concept, not only is there a detailed index of each article, but the actual article can be displayed.



The Articles page

Fred Aslin maintains the Newspapers & Magazines subset and I look after the other sub-sets such as Caving Journals and Trip Reports. This database will eventually replace the Reference section of OzKarst.

OzKarst: holds the CEGSA digital database karst information

Graham Pilkington

Cave Exploration Group of South Australia

It is intended to store all of CEGSA's karst information in OzKarst. This database is a subset of the CEGSA database and can handle karst information from anywhere in the world. The types of data currently stored include descriptive, measurements, drawings, image, biological, and history. OzKarst is based on ASF's karst numbering system, but has been extended to increase versatility and scope. Like all of CEGSA's digital datasets, the indexes can be used to access the data itself. Geological and outcrop data is handled, nearby features can be located, alternate and historical codes used, and data can be loaded into GPS units.

A GIS based on ESRI's ArcMap has been optionally incorporated into OzKarst. This allows karst features to be loaded into multi-layer maps of roads, rivers, topography and other spatial data. Alternatively, a simple feature location plot can be displayed.

Stretcher workshop

Ian Collette[1] and Janice Marsh[2]

1 Western Australian Speleological Group
2 Northern Caverneers

Demonstration of the new ASF website

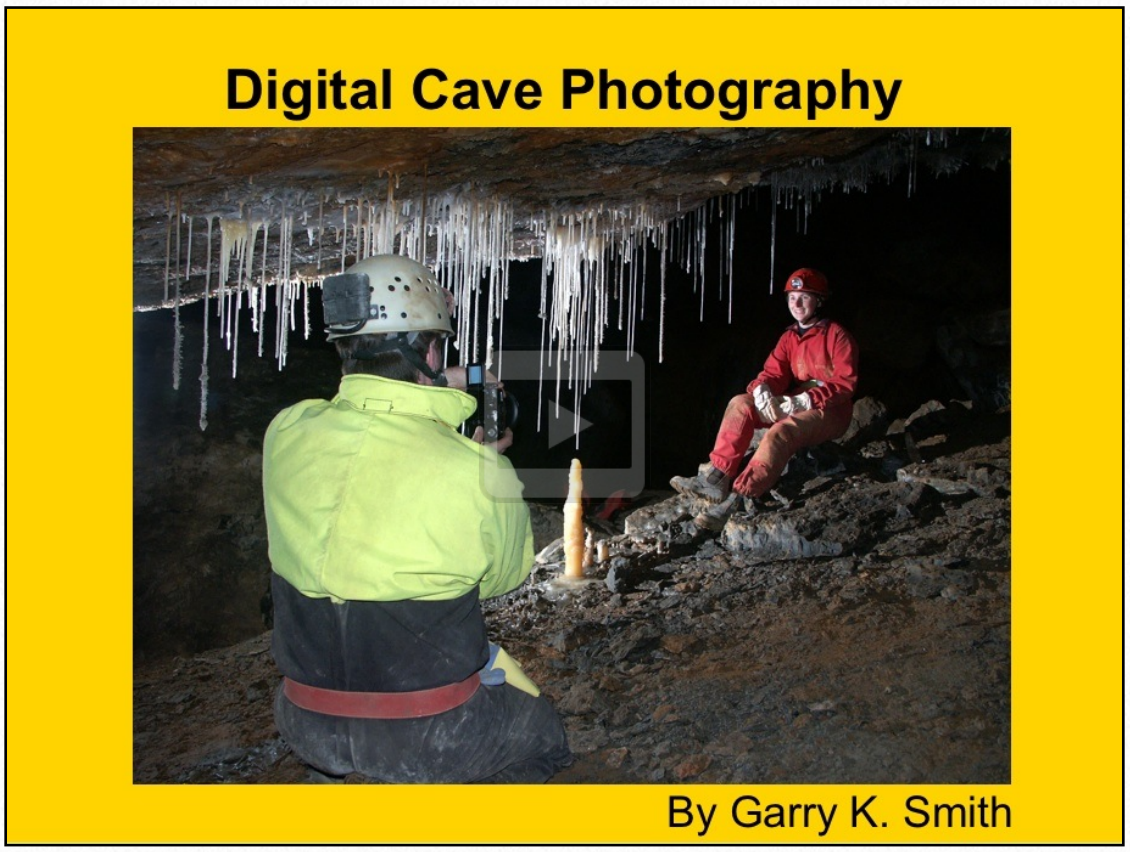
Robert Kershaw

Illawarra Speleological Society

How to improve your cave photos

Garry K Smith

Newcastle and Hunter Valley Speleological Society



Presentation file in PDF format available with the proceedings, courtesy of Garry K Smith

Geology for non-geologist cavers

Susan White

LaTrobe University

Do you really know what limestone is? How is basalt different from granite? What is the difference between a rock and a mineral? How do we describe the basic host of our caves. How has this changed over time? What is the context of fossils? How can I tell if information is seriously out of date?

These and other questions will be explored in a BASIC but hands on geology workshop for non geologists. If you have done some formal geology in the past this is NOT FOR YOU. However if you are confused as to why some rocks look like they do and what the difference between bedding and cleavage planes are, come along for some fun.

Video

http://nswsc.caves.org.au/trogalong/video/geology-for-non-geologists_Sue-White.avi

Biobanking agreements

Peter Dykes

Central Western Caving Group

4

Reports

The Jenolan show cave survey - publish or perish

Julia James
University of Sydney

The Jenolan Caves Survey Project began in the late 1980s, and this presentation is a companion to that given at the ASF conference in 2009. The project aim was to produce a survey, which could be used by others for management and research. This talk will detail the problems encountered as the group strives to get the survey ready as a publication available to speleologists.

The first decision that had to be made was whether the survey should be published in hard or soft copy or as both. The result is that it is being prepared for both. During the preparations problems were encountered with the use of Adobe Illustrator for drafting, especially in the sue of symbol, swatch and brush libraries. The symbol library contains a number of symbols or modifications that do not appear in the accepted survey symbol lists: the rationale for these will be discussed.

A novel way of presenting graphically areas of the cave surveyed with different techniques will be introduced and discussed. The survey has been drawn at a scale of 1:200 and will be reduced to enable publication as a folio of A3 sheets. Jenolan Show Caves have numerous areas with passages overlying those below; two methods of presentation of these areas have been used.

As final drafts have been prepared and checked problems have been noted, such as sections of the dive survey being of doubtful accuracy. These are still being re-surveyed. The representation of many of the Jenolan Show Cave tours has required special thought and will be shown.

Already the survey in its unpublished form has had many uses, one of which developed indirectly, and will be presented at this conference as a paper on the origins of cave and feature names in the Jenolan show caves *(Bellamy and Barnes).*

Video
http://nswsc.caves.org.au/trogalong/video/Surveying-the-jenolan-caves_Julia_James.avi

Scrubby Creek cave acquisition

Nic White and Daryl Carr

VSA and Rimstone Cooperative Ltd.

Abstract

Scrubby Creek Cave was an exploration focus in the late 1950's by the Sub Aqua Speleological Society who tried to dive the resurgence. It was not until 1961 that entry to the cave was gained by bypassing the resurgence. This revealed an initial section above the water until a difficult section was found which required immersion and very little breathing space. The cave continues along the stream for more than a kilometre and the cave has excited cavers for the last 50 years. There are a number of related caves on the Scrubby Creek Property and the neighbouring properties. The caving community has worked with the owners to control access because of the caving difficulties and in doing so developed a very strong conservation ethic for what is a very beautiful and complex cave.

Several cavers were advised that the property was on the market in late 2011 and quick action was needed as this was a once-a-generation chance to acquire the property. Rimstone Cooperative Ltd was started in 1973 with speleological aims and it acquired the Homeleigh property in Buchan. This has provided accommodation for Rimstone members, their friends and families and has always been open to cavers. Rimstone Cooperative is a Community Advancement Society and cannot make or distribute profits to its members. This fulfilled the requirements of compliance for the ASF Karst Conservation Fund to support the acquisition of the Scrubby Creek Cave Property by Rimstone. We thus signed contracts to purchase it and set about raising the funds. We were able to settle in May 2012 with the donations and a few loans.

Rimstone is now preparing a Management Strategy, which involves protecting the cave and karst, particularly the tufa banks and continuing the grazing regime.

The ownership structure will be discussed in relation to private versus public cave conservation of karst resources. The support of all the donors from across the caving community and their friends is acknowledged in this the first such purchase in Australia.

Introduction

Scrubby Creek Cave, M-49 is in the Murrindal area of the Buchan District and is on the western side of the Buchan Basin at the contact with the Snowy River Volcanics and Buchan Caves Limestone (Mill 1979). The cave is some 1.7 kilometres long. The cave was first entered in 1961 but was known from the Scrubby Creek resurgence at the foot of a limestone bluff

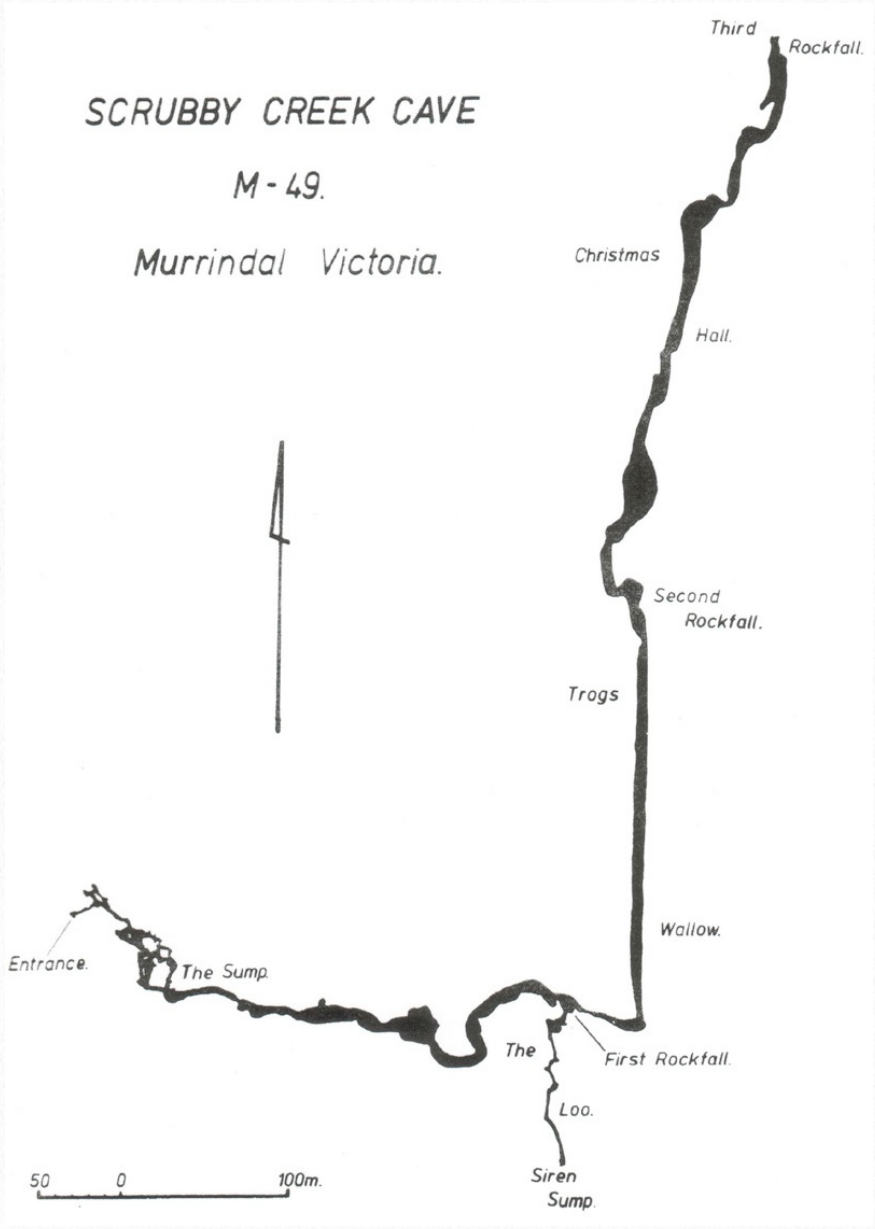


FIGURE 1. *Scrubby Creek cave survey*

much earlier. The exploration of the cave has a rich history because of the challenging obstacles in the way such as sumps, mud and rock falls. There is still much to explore and investigate.

FIGURE 2 *The Homeleigh guesthouse*

The caving community has enjoyed good relations with the Woodgate family since the first successful entry into the cave. Daryl Carr and Lou Williams were offered the Scrubby Creek Cave property when John (Grub) Woodgate's daughter Lauren decided to put the property on the market in October 2011. They were not able to purchase it themselves and put it up as a proposition that cavers through Rimstone Cooperative Ltd could buy the property. I need to fill in some background here because in 1974 the Victorian caving community established Rimstone Cooperative Ltd to support cave conservation and the aims of the caving community. Rimstone Cooperative is a Community Advancement Society which cannot declare a dividend and has to pass on its assets to a like-minded organization if wound up. The first objective was to resolve a problem with caver accommodation at Buchan and Rimstone purchased the Homeleigh guesthouse shortly after being established. This had become necessary because there were no suitable premises suitable for rent and the alternatives of camping were not good for year round caving. At the time the purchase price of $12,000 seemed enormous. Funds from accommodation fees have been used to renovate the property ever since. At several stages we have investigated purchasing caving properties but we did not have the money or resolve at the time. However, we have successfully operated in Buchan since 1974.

With Rimstone Cooperative Ltd we had both an organization and structure applicable to acquiring a cave property and experience in managing property. The Scrubby Creek Cave property had one of Victoria's iconic caves with other prospects as well.

Property Acquisition

During November and December 2011 the directors of Rimstone established that there was sufficient support for us to negotiate with the estate agents to acquire the property but we needed the support of the wider caving community to do so. This is where the ASF and the ASF Karst Conservation Fund came in. We needed to have the acquisition as an approved project of the Fund to firstly have tax deductibility and secondly to pull in the support of the wider ASF caving community. On behalf of Rimstone, I made application to the Directors of the ASF Karst Conservation Fund with background on the Cooperative as being a suitable body to acquire the Scrubby Creek Cave Property for posterity. This hit the summer period and the Fund Directors were on holiday that necessitated some prevarication on my part in negotiating with the estate agents until the Fund Directors approved the

Figure 3. Scrubby Creek tufa terraces

project. There was also the problem of holding the property from being sold out from under us. I placed a deposit of $200 on the property, not the usual 10% of contract price, to prevent it being snapped up by firstly a group of motorcycle riders and then a builder who liked the area. The ASF Karst Conservation Fund Directors approved the project at the end of January and established conditions for the project. The Rimstone directors immediately signed a Contract of Sale for the 105 acres with the cave entrance, the spring and tufa terraces and paid a full 10% deposit with settlement in early May 2012.

Fundraising was the next stage. Raising over $100,000 for the property was a challenge as only some of it was promised and only a small amount was available from Rimstone Cooperative funds as these have been needed to upgrade and renovate the Homeleigh premises. The Rimstone directors resolved that all new membership fees should go to the capital purchase. Publicity was immediately set in place with an appeal brochure and article in Caves Australia (White 2012); follow-up contact with VSA and Rimstone members and an ASF Website appeal notice. Many friends of VSA and Rimstone members additionally were asked to donate to the project. It is remarkable that close friends preferred our appeal instead of their usual charity donation this year. Additional to this we investigated obtaining a loan or part loan to purchase the property. It was instructive to learn that despite Rimstone Cooperative always showing a small profit for over 30 years, our advisor said after looking over five years of audited accounts that “we were not a lendable entity”. This advice came within 24 hours and we then knew that with a contract to meet we had to obtain personal loans for any shortfall on the fundraising side.

Donation source	Number of donors	Proportion of total
Rimstone and VSA members	47	79
ASF members	13	11
ASF clubs	6	4
Friends	14	6
Total	**80**	**100**

Figure 4. Donation analysis

By the end of March 2012 we had raised or had in place the funds to pay the full Contract price for the property. I was able to go on the VSA Nullarbor trip comfortable that settlement could be met in early May. This was made up of over $60,000 raised through the ASF Karst Conservation Fund and about $15,000 donated directly to Rimstone Cooperative. The balance was from Rimstone’s consolidated accounts and loans from individuals. I will record here that VSA and Rimstone members contributed 80% of the raised funds; ASF members interstate 11%; ASF clubs 3.5 %; other non-caving friends 5.5%. We always knew that the funds would come mainly from Victoria but it we were very heartened by the support of individuals and member clubs directly. The fund raising is not finished as we have loans from a number of individuals which still need to be acquitted. The Contract was aquitted in early May and we now have the Title to the property.

Scrubby Creek Cave Property Management

Farming properties need management. It is a “rough” grazing property. Buchan was settled following drought on the Monaro in NSW during the 1830’s. The limestone land in the Buchan district had grassland and box woodlands suitable for grazing. The adjacent Snowy River Volcanic lands were not arable or suitable for grazing. The good limestone land was taken up early and later broken up. We have now leased the property for grazing but retained access and responsibility for weeds.

A caving access agreement is broadly in place with VSA and is based on a continuation of the Special Leadership for Scrubby Creek Cave which was in place with the previous owners. This is based on cave leaders with a familiarity and knowledge of the cave, in particular the sump. Caving access for Scrubby Creek Cave and the other caves on the property will require each trip to be on the VSA trip calendar and participants will require ASF insurance cover or similar. Similarly, cave exploration and investigation involving digging will require a full plan approved by VSA and Rimstone. Rimstone Cooperative Ltd is the property owner and cavers need to realise it is not VSA, although there are close links.

Rimstone is currently planning protective works for the tufa terraces. This may involve fencing, the installation of run-of-stream water troughs and some enhancement work on the

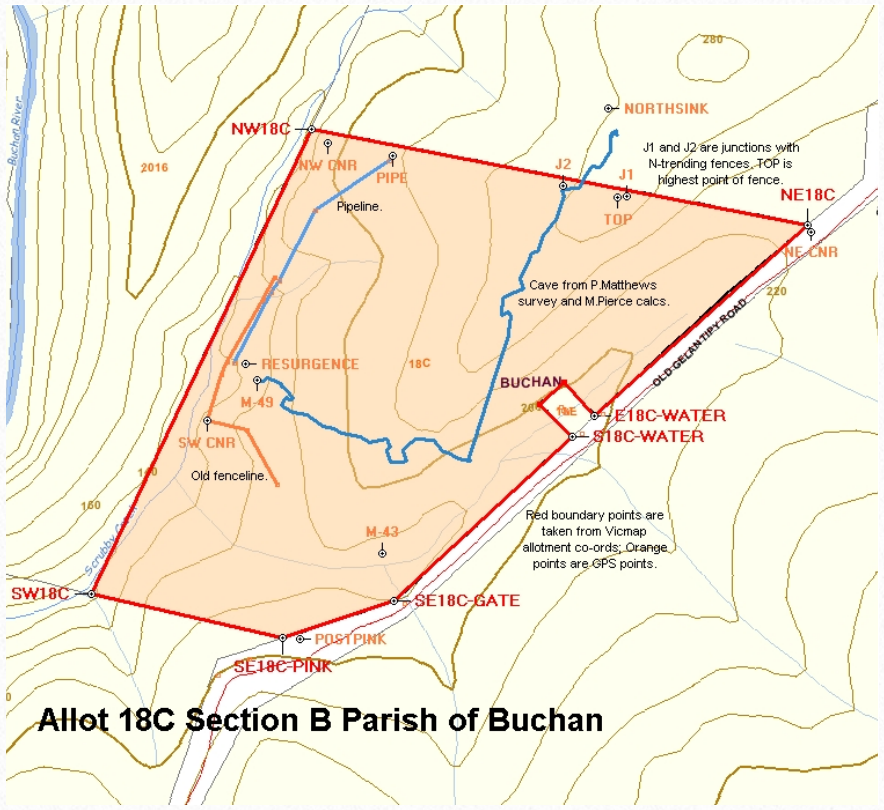


FIGURE 5. *Scrubby Creek Property with Cave Outline*

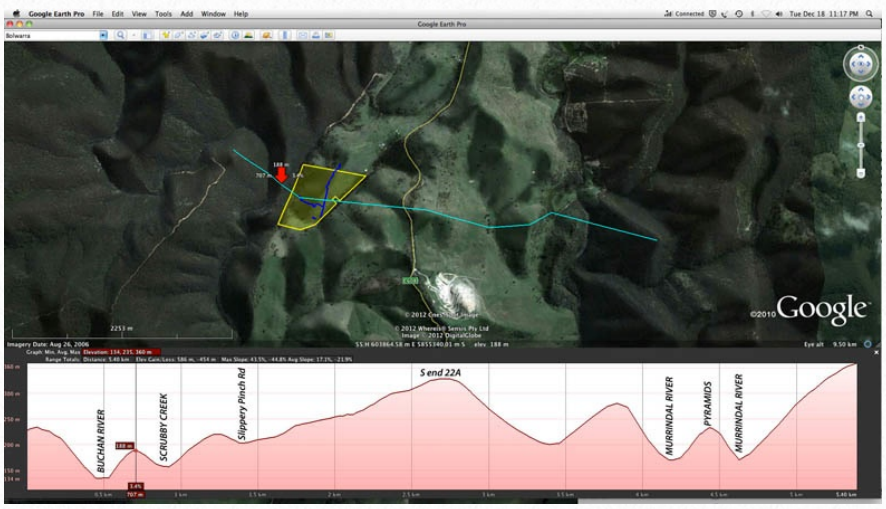


FIGURE 6. *Profile Buchan to Murrindal*

terraces. These have suffered from trampling and clay buildup due to cattle access. Scrubby Creek has remnant rainforest species typical of East Gippsland. This stream riparian vegetation will be further investigated as it is in very good condition and deliberate protection may attract funding support. Little is known of the cave biota but this needs studying particularly for the any stygofauna.

Weed control planning is underway for blackberry, thistle (several species) and horehound etc. This will involve a serious amount of work initially and then will be ongoing.

In October 2012, we had a formal launch on the property to celebrate becoming the new owners. This was attended by adjoining land owners, Buchan community members and VSA and Rimstone members. The East Gippsland MLA for Victoria Mr Tim Bull attended and officially opened the event with an acknowledgement of the part cave tourism contributed to the local community and our part in this. We then had lunch followed by tours of the property including the cave entrance and tufa terraces. In the evening we had a barbeque at Homeleigh and a Scrubby Creek Cave trip the next day. This was all reported in the local community newsletter (Buchan Bulletin 2012).

Reflections on the Acquisition

Before and after becoming Chair of the ASF Conservation Commission, I have made a point of trying to have caves protected. Certainly a large proportion of cave areas have now been reserved around Australia through State Government processes and because of conservation pressures exerted by the caving community and others. This process of adding cave areas to National Parks and Reserves is coming to an end. In Eastern Australia, most arable land was taken up at the time of settlement and this included limestone areas often with significant caves and karst. These areas are now part of the privately owned cave estate.

In USA, the NSS have responded to need by establishing Cave Conservancies (White 2009). These provide for protecting a range of caves important for recreation but also significantly for their wider cave values such as bat habitat. In Hawaii the Cave Conservancy of Hawaii has been purchasing properties with lava tubes in a serious way with annual purchases of allotments with caves.

In Australia, significant privately owned karst areas deserve our attention as it is becoming much more difficult to persuade State Governments that particular pieces of land need acquisition for features such as caves. Sand Cave at Naracoorte was considered for caver acquisition but it was out of our price range. We provided cave information to the Naracoorte Caves staff which enabled the property to be acquired by the State and this property has now been added to the Naracoorte Caves National Park. A significant property at Mt Sebastopol near Kempsey NSW was out of our price bracket but is high on a NSW Government acquisition list. Pungalina Station on which VSA has been exploring caves was purchased by the non-government agency the Australian Wildlife Conservancy in 2008. Other properties at Mole Creek Tasmania

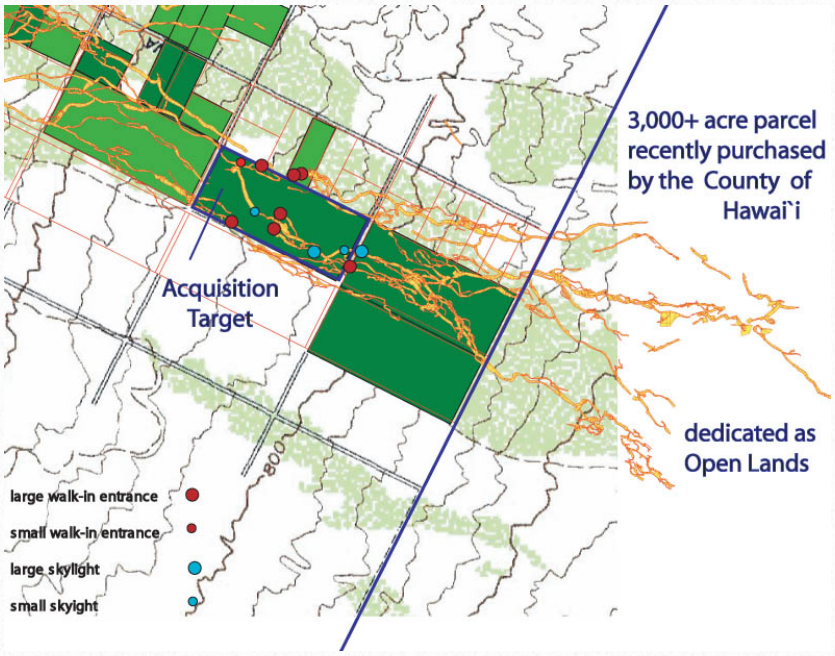


FIGURE 7. *Hawaii Bigelow Purchase*

might deserve caver interest. There is a very significant cave property in Western Victoria that warrants evaluation but Victorian cavers need to recover and consolidate after the Scrubby Creek Cave purchase before contemplating another such venture.

I did not expect that having talked up the proposition that cavers acquire caves in Caves Australia in 2009 that it would be Victorian cavers that would be the first to do so. At least we have a very suitable organization in Rimstone Cooperative with right aims and objectives and the management experience to purchase a cave property. ASF member clubs and ASF itself are now incorporated and can acquire property but as in Victoria it would be extremely useful to have ownership and management of cave properties at arms length from cavers. In fact, during several years of negotiations with Cement Australia regarding part of Mt Etna Quarry in Queensland ASF Inc itself was to be gifted the land on the basis it was not wanted by the Queensland Department of the Environment for addition to the Mt Etna Caves National Park. Details of how ASF was to manage the land were never worked through by ASF because the land was gifted to the State instead of ASF.

Conclusion

Rimstone Cooperative Ltd purchased the Scrubby Creek Cave property with the support of its members, cavers, friends and ASF itself. This purchase was a once-a-generation opportunity to acquire it for cave protection and recreation purposes. The chance would have been lost in a matter of weeks without prepared minds able to commit to the project immediately. We still owe money but we have an iconic cave to manage together with the weeds! Acquisition of Scrubby Creek Cave is the first of what should be further purchases to protect caves by the ASF community.

References

Brain, Rob. Rimstone Co-op Celebrates Scrubby Creek Purchase, *Buchan Bulletin*, No. 55 p 5, Nov 2012.

Mill, Lloyd. Scrubby Creek Cave *ASF Newsletter,* No. 85, 1979.

White, Nicholas. Cave Conservancies, Conversation on Conservation, *Caves Australia,* No 179, p 36-37, 2009.

White, Nicholas. Scrubby Creek Cave M-49, Conversation on Conservation, *Caves Australia* 188, p 7, 2012.

5

Conference photographs

Photography by Garry K Smith

David Cook accepts a Certificate of Merit on behalf of Kath Bellamy

Stan presents Jenny Whitby with her Certificate of Merit

Denis Marsh accepts a Certificate of Merit on behalf of the Dunhill family

Fran Head accepts a Certificate of Merit for Jay Anderson

Certificate of Merit being awarded for Ann-Marie Meredith

Jessica Bales accepts ASF Certificate of Merit on behalf of Lyndsey Gray and Paul Darby

Photography by Garry K Smith

Peter Freeman receives his Certificate of Merit

Alison Scobie accepts the Certificate of Merit on behalf of David Dicker

David Wools-Cobb accepts his Award of Distinction for cave and karst conservation

Peter & Yularna Dykes accept the Peter Berrill Award of Distinction for Cave &Karst Conservation

Photography by Garry K Smith

Al Warild presents the after dinner speech at the Cavers' Dinner