GUIDEBOOK TO THE CAVES OF SOUTHEASTERN NEW SOUTH WALES AND EASTERN VICTORIA

by

ROBERT S. NICOLL and JOHN B. BRUSH

and

CAVES AROUND CANBERRA

by

J.N. JENNINGS

AUSTRALIAN SPELEOLOGICAL FEDERATION

GUIDEBOOK 1

1976

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AUSTRALIAN SPELEOLOGICAL FEDERATION GUIDEBOOK 1

Prepared for CAVCONACT-76

The Eleventh Biennial Convention of the Australian Speleological Federation held at the Australian National University, Canberra.

December 1976

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* initials in parenthesis indicate author

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INTRODUCTION

The southeastern part of New South Wales, eastern Victoria and the Australian Capital Territory are blessed with numerous limestone bodies and a reasonable number of caves (fig. 1). For this convention we have not tried to make available all caves in all areas for the visitor to see but have tried to pick a limited number of caves from selected areas that will show the visitor a reasonably true cross-section of the type of caves in the region.

In selecting our areas we have tended to leave out those which contained only a few, relatively small caves or areas where we have had landowner relationship problems. In addition we are encouraging you to visit several or all of the areas rather than to concentrate your efforts on a single area such as Bungonia or Yarrangobilly. We believe that by doing this you will get a much better feel for the caves of southeastern Australia.

We have selected 4 to 6 caves from each area for which we have given where possible, location information, descriptions, maps and other information to assist you in your visit to the caves. For those caves included in the guidebook we have obtained permission for all ASF members to visit at the time periods specified. Please note that some of the areas or caves are available for only certain restricted days (see Table 1). This has resulted from our desire to keep landowner relationships on the best possible terms.

If you should wish to visit caves not included in the guidebook please contact members of the Canberra Committee to determine if visits to that area are feasible.

We have also tried to include other information about the caves and cave areas that should make your visit easier. For each cave we have tried to give an idea of how long it would take to see most of the cave without rushing. If you take lots of photographs you will take longer than we have estimated. If you run through caves, then cut the time somewhat. Because most of our caves involve some walking from car parking areas we have tried to give an estimate of walking time to the cave entrance. We have also included some indication of the photographic potential of each cave. Special equipment for each cave is noted. In some caves we have rigged ladders but check with the area co-ordinator for specific details.

TABLE 1, ACCESS TO CAVE AREAS

For CAVCONACT-76 arrangements have been made for conference registrants to visit the selected caves and cave areas for the periods designated below. Late changes and any additions will be posted on the Field Trip Board (FTB) in Burgmann College. For sign up sheets for trips to restricted caves or areas see the FTB.

CANBERRA KARST REGION

Paddys River Cave Area — Dec. 27 to Jan. 2.

Caves locked, see FTB for information

London Bridge Cave Area — Dec. 31 to Jan. 1

Karst Field Trip - 1400 hrs. Dec 31, see FTB for other times and meeting place for Karst Trip

BURRINJUCK KARST REGION

Wee Jasper Cave Area — open area

Visitors are requested not to visit Church Cave or the Thermal Paddock areas because of the bat maternity colonies. Landowner problems in the north of the area generally restrict access to these areas

TABLE 1. (continued)

Taemas Cave Area — see FTB

Two trips by road will be held to Narrangullen Cave. Times and meeting place given on the FTB. The cave may be approached by boat at any time.

FIERY RANGE KARST REGION

Black Perry Cave Area — Jan. 6 to Jan. 10.

Trips into this area will be organized from Cottrils Cottage, at Yarrangobilly, sign up at the FTB.

Cooinbil Cave Area — open area

Cooleman Cave Area — Dec. 31 to Jan. 16

No coordinator in the area. For more information contact the coordinator at Cottrils Cottage, Yarrangobilly Village.

Yarrangobilly Cave Area — Jan. 3 to Jan. 16

Coordination point is Cottrils Cottage at Yarrangobilly Village. Keys for gates, trail information and cave maps will be kept here. Remember that Cottrils is not available for accomodation. Camping is available along the Yarrangobilly River close by.

UPPER SHOALHAVEN KARST REGION

Big Hole Cave Area — Dec. 31 to Jan 16

Wyanbene Cave Area — Dec. 31 to Jan. 16

Marble Arch Cave Area — Dec. 31 to Jan. 16

Acoordinator will be in the above areas for part of the field trip period, for details see the FTB. Visitors to the Big Hole - Marble Arch Areas are requested to check in and out with Mr. Jim Dempsey of Emu Flat.

Bendethera Cave Area — Dec. 31 to Jan. 16

Illawarra Speleo. Soc. has tentative plans to run a trip into this area for the Convention. Check on the FTB

LOWER SHOALHAVEN KARST REGION

Bungonia Cave Area — open area

SOUTH COAST SEA CAVES — open region

Because this is such a diffuse region we have not attempted to check with local landowners. Most of the caves are located on puplic property along the sea shore

BUCHAN DISTRICT, VICTORIA — Jan. 1 to Jan 16

Area coordinated by VSA, see information in the guidebook and also the FTB

JENOLAN CAVE AREA

This area has not been written up for this guidebook because it is expected that a Jenolan book will be available by the time of the Convention. Trips to the area will be coordinated by SUSS, so see the FTB for more information.

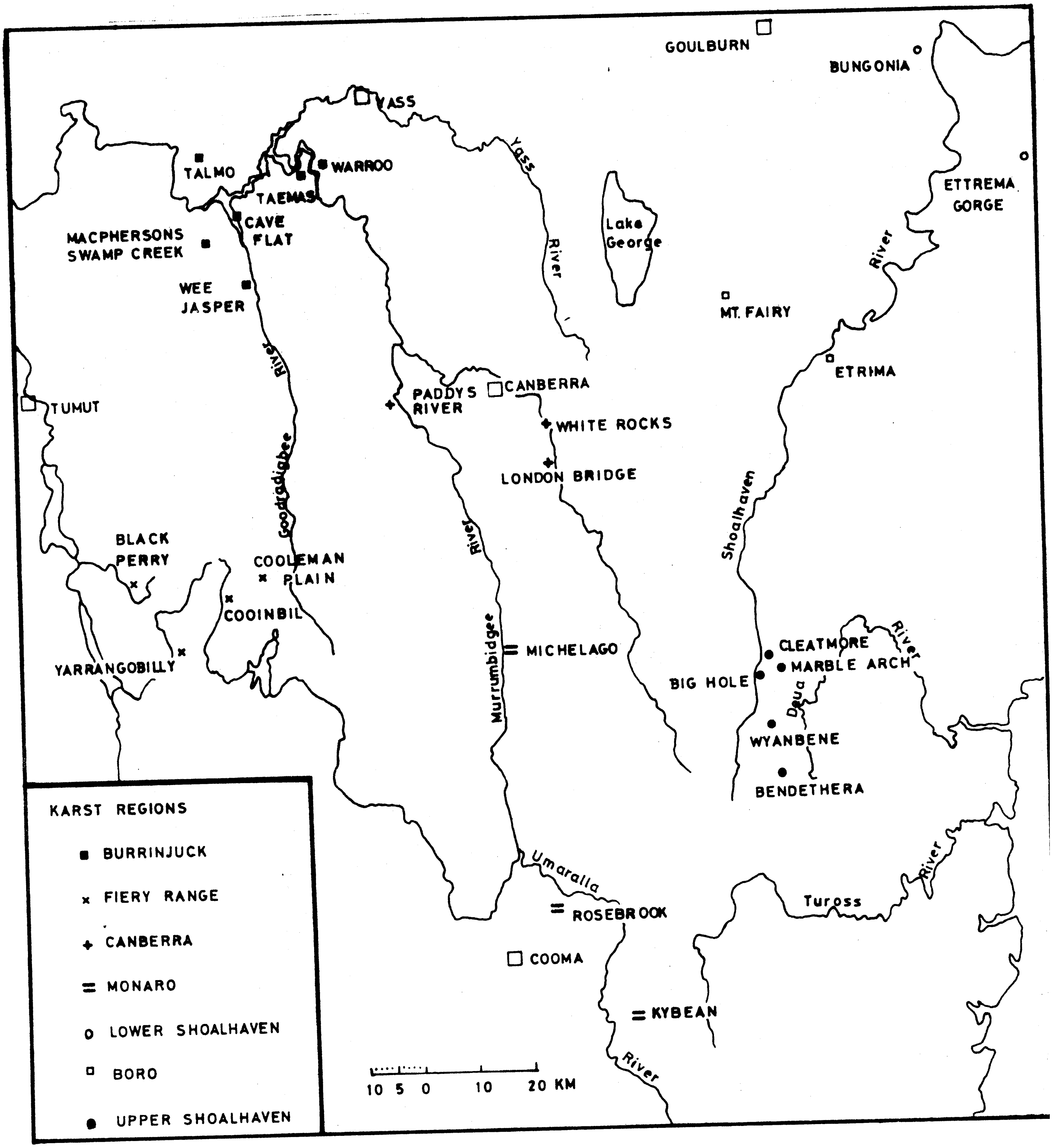


Fig. 1, Location of Karst Regions and Cave Areas in southeastern New South Wales

CANBERRA KARST REGION

There are numerous limestone lenses in the Canberra Karst Region, but most are small and do not contain caves. We have selected two that do contain small caves as representatives of the region. The areas are London Bridge and Paddys River.

Most limestone lenses in the immediate vicinity of Canberra are of Silurian age. The limestone is usually found in lenses a few metres thick and less than a kilometre long. Frequently, the limestone (or marble) is interbedded with, and may laterally grade into, shale or volcanic rocks (e.g. London Bridge Area). Some of the lenses have been strongly metamorphosed and the limestone recrystallized to form marble (e.g. Paddys River Area).

As a function of the small size of the limestone lenses and the generally low relief adjacent to the exposures, caves formed in this region are generally short. Cotter Cave (Paddys River) is only 65 m long and no single cave at London Bridge is in excess of 45 m in length. Despite their short length, the caves are of reasonable complexity.

PADDYS RIVER CAVE AREA

The Paddys River Cave Area is the best known and only presently accessible limestone cave area in the ACT. Located adjacent to Paddys River, upstream from its junction with the Cotter River (fig. 2), the area is 20 km W of Canberra and is reached by driving along the Cotter Road to the Cotter Recreation Reserve. Park in the reserve and walk to the area by crossing the Cotter River near its junction with Paddys River and follow the latter about 400 m upstream. The limestone is on a hill on the western side of the River and the main cave is found by following the obvious track up the hill.

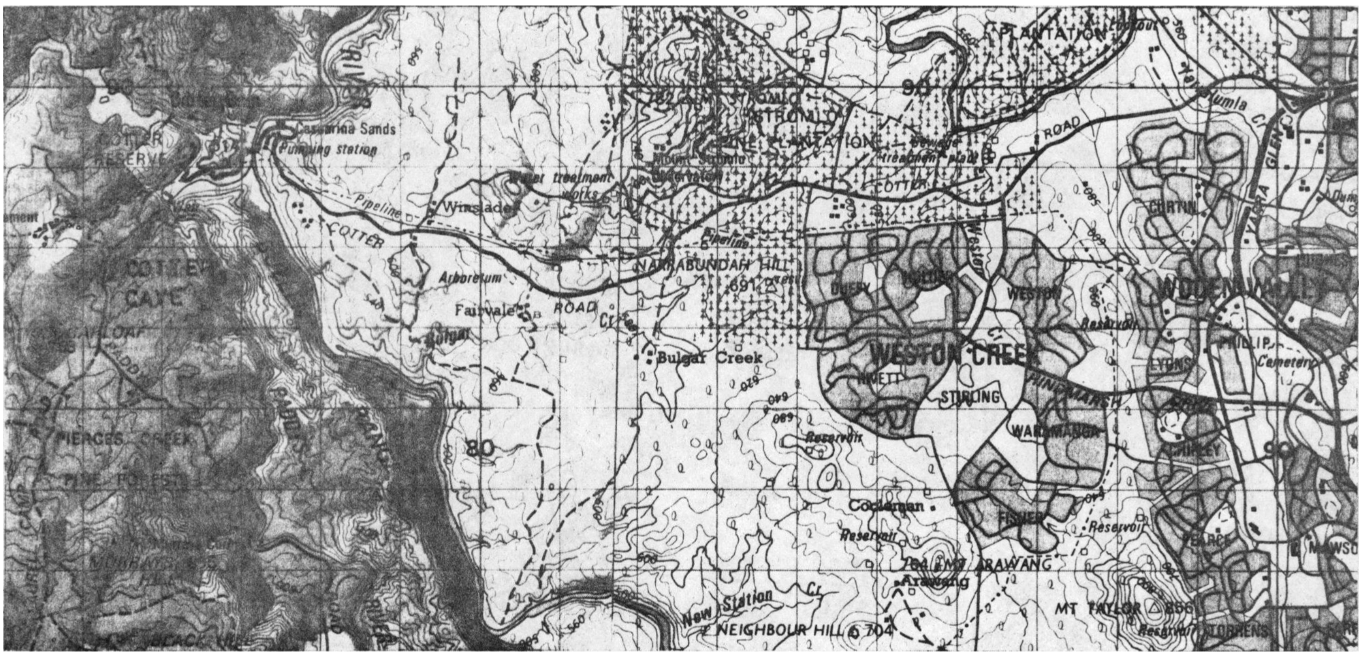


Fig. 2, Location map of the Paddys River Cave Area. Brindabella and Canberra 1:100,000 topographic maps.

The cave is developed in a recrystallized limestone (marble) lens that has nearly vertical bedding and lies within the Silurian Paddys River Volcanics. To the west, there is a sharp transition from the limestone into a skarn rock that is mostly magnetite. A small exploratory mine, 200 m long, was driven into the magnetite body in the 1920's and several million tons of reserves are present.

There are three caves in the Area (Nicoll & Brush, 1975a). Cotter Cave is the largest with about 65 metres of passage, while Powder Store and Blasted Caves are each only a few metres long. Entry to the caves is regulated by the City Parks Administration of the Department of Capital Territory, and the entrances have locked gates.

Cotter Cave (PR1)

Time - 45 min. Walking time - 20 min each way.

Photography - generally poor, interesting flat roof levels.

Equipment - none

References - Nicoll & Brush, 1975, TVL 7 (4), 3-8.

Entry - Cave is gated and locked (access controlled by City Parks Admin., Canberra).

Cotter Cave may be regarded as semi-developed for tourists because wooden entry stairs and some stone steps have been erected in the cave. However there is no known commercial attempt to develop it as a show cave. The entrance stairs drop 6 m to a small platform and then a further descent of 9 m over rubble brings one to the main floor level of the cave (fig. 3). The large passage is about 10 m wide and 12 m high at that point. The main passage leads back into the hill for another 50 m where the passage is terminated by clay and gravel fill at floor level and by bedrock above. About 4 m above the floor a very tight crawl leads on to a small chamber. The aven near the end of the cave has been climbed but does not lead to additional passage.

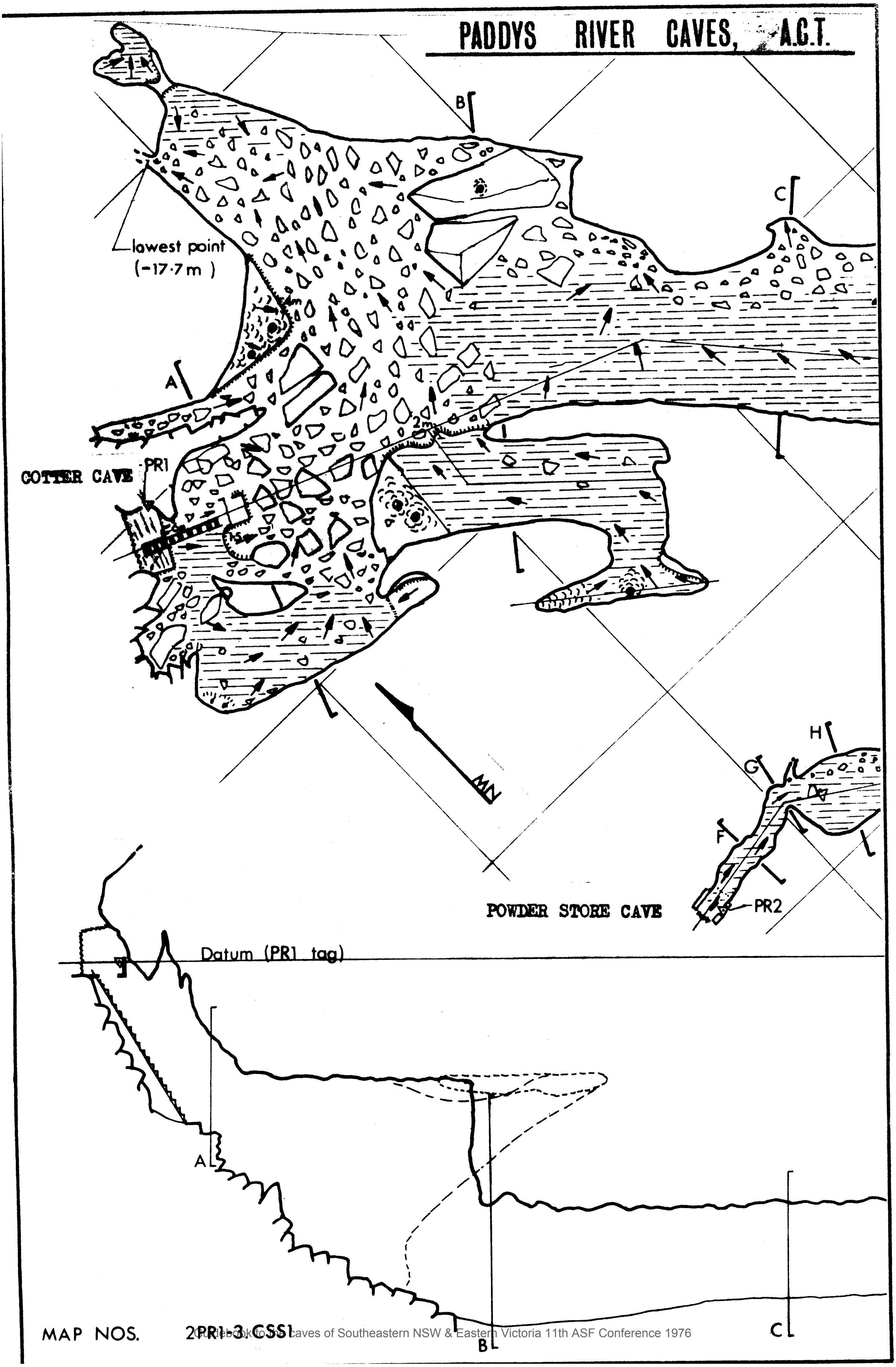
There are few speleothems remaining in Cotter Cave. It was never over-endowed with speleothems (as far as one can tell) but abuse by visitors over the years has largely removed those that were there. There is no evidence of an active stream flowing in the present cave but the sediment in the cave was deposited by stream action. Also of note are the two levels of flat roof development that are related to periods of stability in the groundwater level during the history of development of the cave.

Powder Store Cave (PR2) & Blasted Cave (PR3)

These two small caves are probably abandoned upper levels of Cotter Cave (fig. 3). Both are gated and locked. Neither is more than 15 m long and they lack any significant features. We recommend their examination only to those people who want to say that they have been into all of the caveable caves in the A.C.T.

LONDON BRIDGE CAVE AREA

The London Bridge Cave Area is located on Burra Creek, 1.5 km upstream from its junction with the Queanbeyan River and 18 km S of Queanbeyan (fig.4). The London Bridge Area has 8 tagged entrances that lead to 5 distinct but closely related caves. All of the caves, including London Bridge itself, are developed in a small limestone lens which is part of the Cappanana Formation. Similar small limestone lenses south of London Bridge contain a few small caves but none that compare with the main area.


PADDYS RIVER CAVES, A.C.T.
lowest point
(-17.7m)
A
B
C
COTTER CAVE
PR1
2m
MN
H
G
F
POWDER STORE CAVE
PR2
Datum (PR1 tag)
A
B
C
MAP NOS. 2PR1-3, CSS1

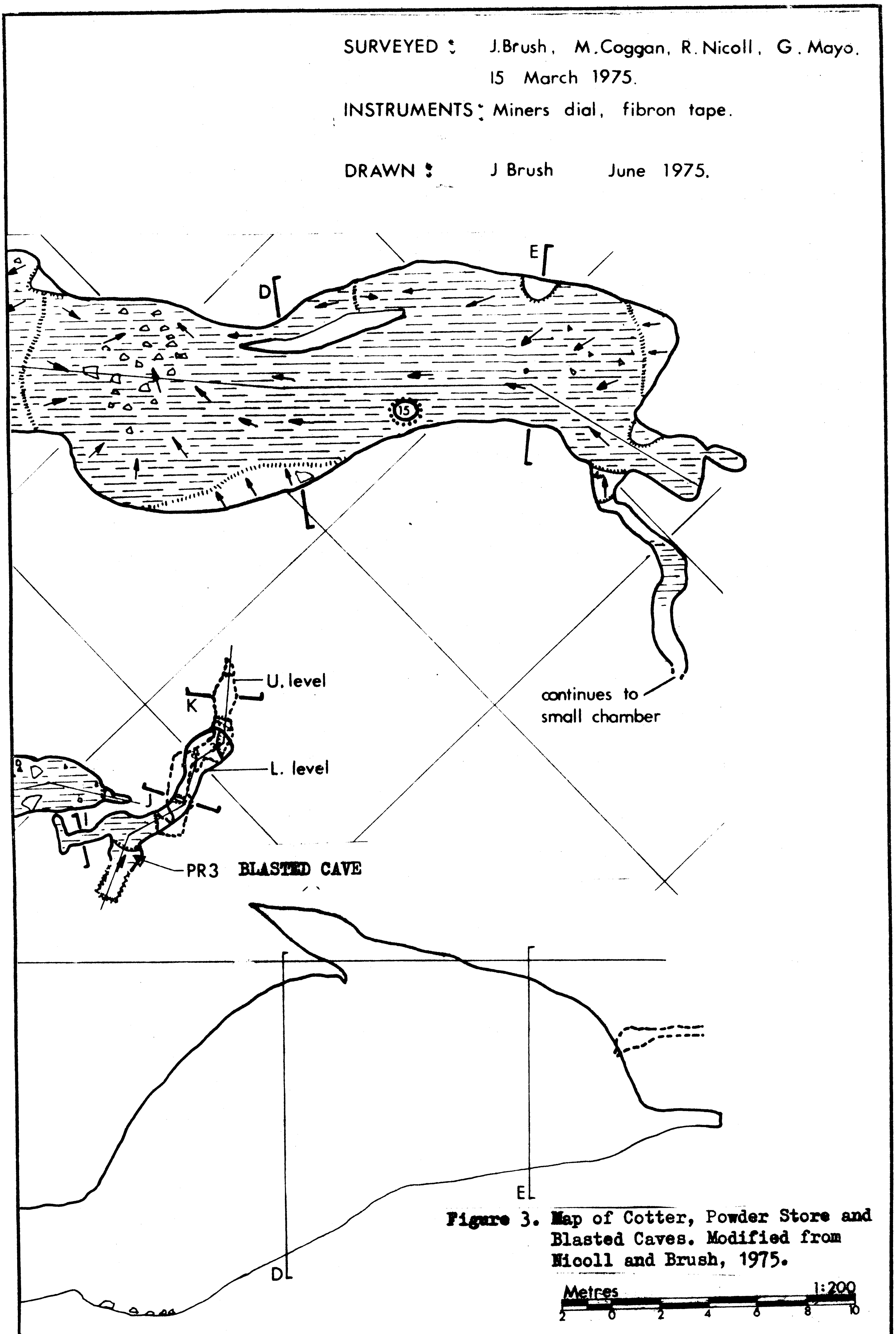


Figure 3. Map of Cotter, Powder Store and Blasted Caves. Modified from Nicoll and Brush, 1975.

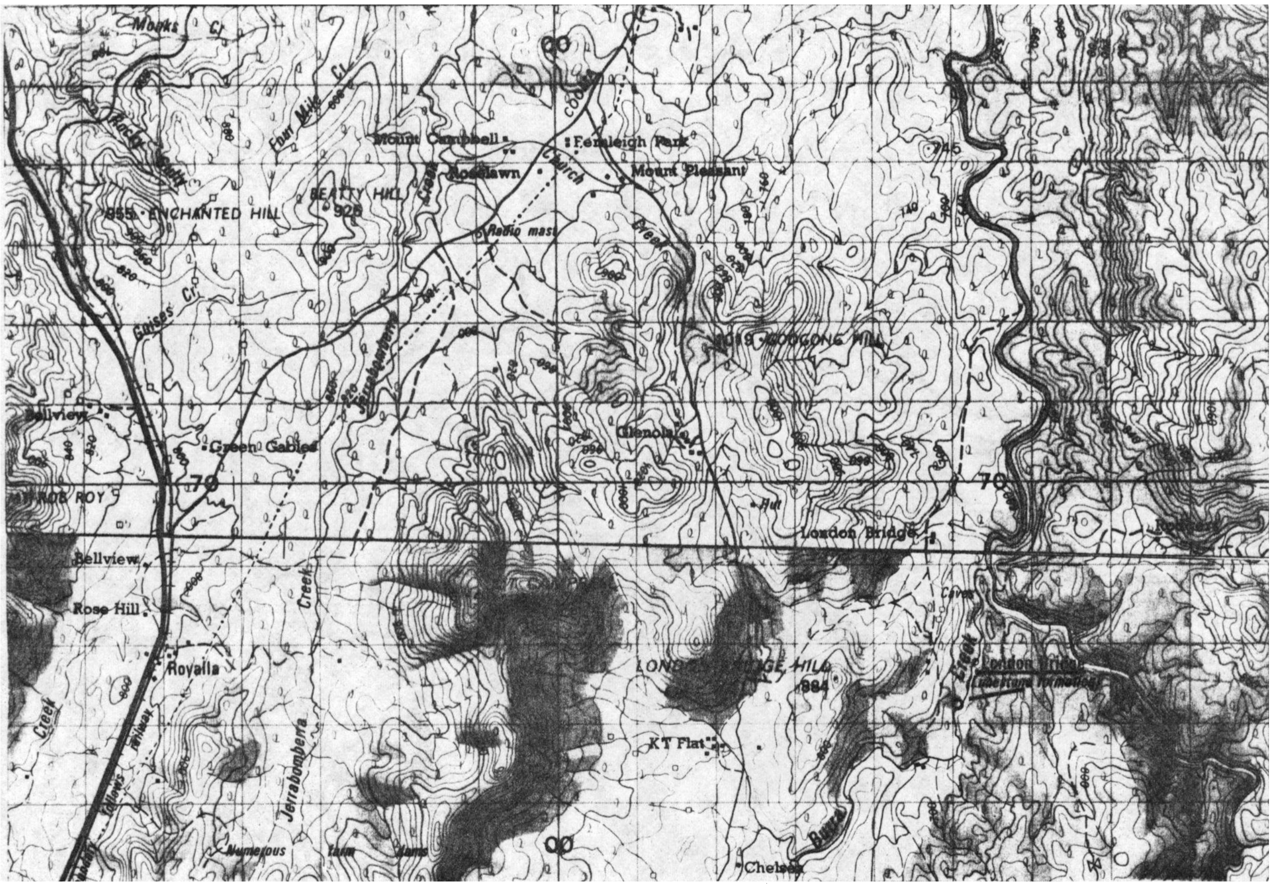


Fig. 4. Location map of the London Bridge Cave Area. Canberra and Michelago 1:100,000 topographic maps.

London Bridge is reached by following the Cooma and Burra Roads from Queanbeyan. The area is now under control of the Conservation & Agriculture Branch, Department of Capital Territory and plans are being developed to make the area into a public recreation area associated with the new Googong Reservoir, now under construction on the Queanbeyan River. When completed, water from the dam will be ponded, at maximum capacity, almost to the level of London Bridge. However, the area should escape drowning except during extreme flood periods.

London Bridge Area Caves

Time - 1 hr Walking time - 5 min. each way

Photography - good photos of natural bridge

Equipment - none

References - Nicoll & Brush, 1975, TVL, v.8 (2), p.17-24;
Jennings, Brush, Nicoll & Spate, 1976, Australian Geographer.

Entry - the area is controlled by the Conservation and Agriculture Branch, Department of Capital Territory, Canberra.

London Bridge Cave (LB1)

London Bridge Cave is a simple arched passage that is 34 m long, 12 to 15 m wide and up to 5 m high (fig. 5). The cross-section is slightly asymmetrical with the east wall less steep than the west. Burra Creek flows through the cave and is up to 1.5 m deep in pools at the upstream and downstream entrances. The bedrock floor is covered by up to 3 m of sand and gravel in most parts of the cave.

Burra Cave (LB2,3)

Burra Cave has two entrances, 34 m apart, and about 60 m of passage (fig. 5). Walk-in entrances lead to a low central crawlway section. The connecting link between the two entrances is a very tight crawlway that only small children and such like are able to get through. There are a few speleothems on the walls and part of the cave floor is composed of flowstone but no speleothems of great beauty are found in the cave.

Douglas Cave (LB6,7,8)

This cave has three entrances, all on, above, the west bank of Burra Creek, just downstream of the entrance of London Bridge Cave (fig. 5). Douglas Cave is 42 m long, lacks prominent speleothems but does have a pitch entrance with a drop of 8.5 m.

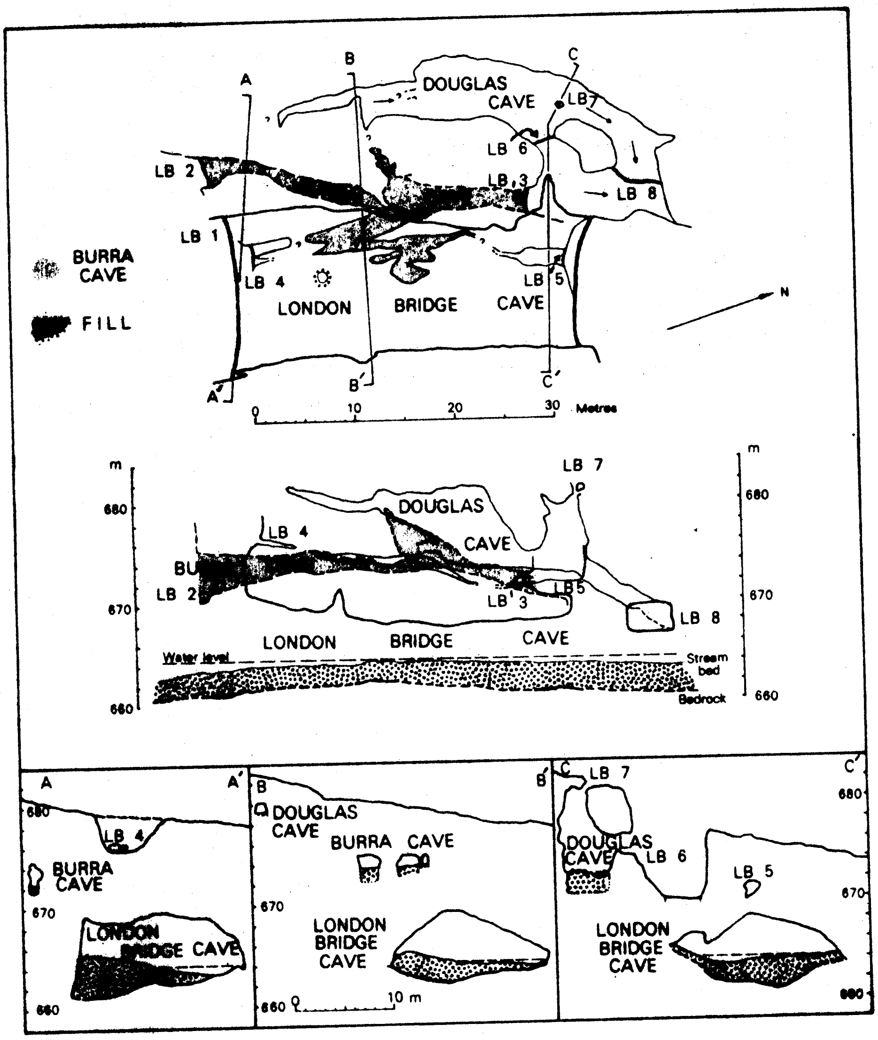


Fig. 5. Plan, projected profile and sections of London Bridge Area Caves. (after Jennings et al., 1976)

BURRINJUCK KARST REGION

The Burrinjuck Karst Region is centered around Burrinjuck Dam, south-west of Yass and 40 km north-west of Canberra. The region is composed of three major cave areas, Taemas, Warroo and Wee Jasper, and a number of minor areas. Caves in two of these areas, Wee Jasper and Taemas, are described in this guidebook.

Caves at Wee Jasper and Taemas-Warroo are developed in limestone of Early Devonian age. Topographic relief on the limestone is relatively low, up to about 100 m, and as a result most of the development in the major caves, such as Punchbowl or Narrangullen, show primary horizontal development.

Accommodation and Provisions

Camping is available along Wee Jasper Creek near Punchbowl Hill. The shire collects a small fee for camping. Bring your own water. Petrol and some supplies may be purchased at the Somerset Caravan Park and the Wee Jasper store but major purchase should be made in Canberra or Yass.

WEE JASPER CAVE AREA

The Wee Jasper Cave Area is located in the lower reach of the Goodradigbee valley and extends 8 km north and 4 km south of the Wee Jasper post office (fig. 6). The southern arm of the limestone extends up the Wee Jasper Creek valley for about 1 km.

North of Wee Jasper most of the caves are small, and many are joint or bedding plane controlled. Some larger caves are developed in small limestone reefs near the top of the limestone. Carey's Cave is a compact, well decorated, commercially developed cave located 6 km north from the Wee Jasper P.O. The cave is worth a visit.

South of Wee Jasper caves are concentrated in two areas, the Thermal Paddock and Wee Jasper Creek. Caves in the Thermal Paddock are mostly small and are not considered here. The Wee Jasper Creek caves include Dip Cave and the Punchbowl-Signature-Dogleg Cave System and show primarily horizontal development with interconnecting vertical passages. Descriptions of these caves are given below.

The two largest cave systems at Wee Jasper, The Dip and Punchbowl Caves, are probably as well surveyed and documented as any cave system in Australia (Jennings, 1963, 1964) and as such are well worth the attention of speleologists. They are also possibly the two most heavily used non-developed caves in the country and as such provide a useful training ground for scouting and other similar groups.

The Dip Cave (WJ 1-5)

Time - 5 hours Walking time - parking beside entrance.

Photography - good

Equipment - 10 m ladder, rope, hand lines

Reference - Jennings, J.N., 1963, Geomorphology of the Dip Cave, Wee Jasper, NSW., *Helictite*, I : 43-58.

The Dip Cave (G.R. 529089 Brindabella 1:100,000) is located about 4.5 km due south of Wee Jasper village on the Micalong road. In plan it consists of five parallel interconnected passages strongly dominated by the structure of the limestone (fig. 7). The cave is thought to be phreatic in origin but has been greatly modified by breakdown. Over 1000 m of passage is

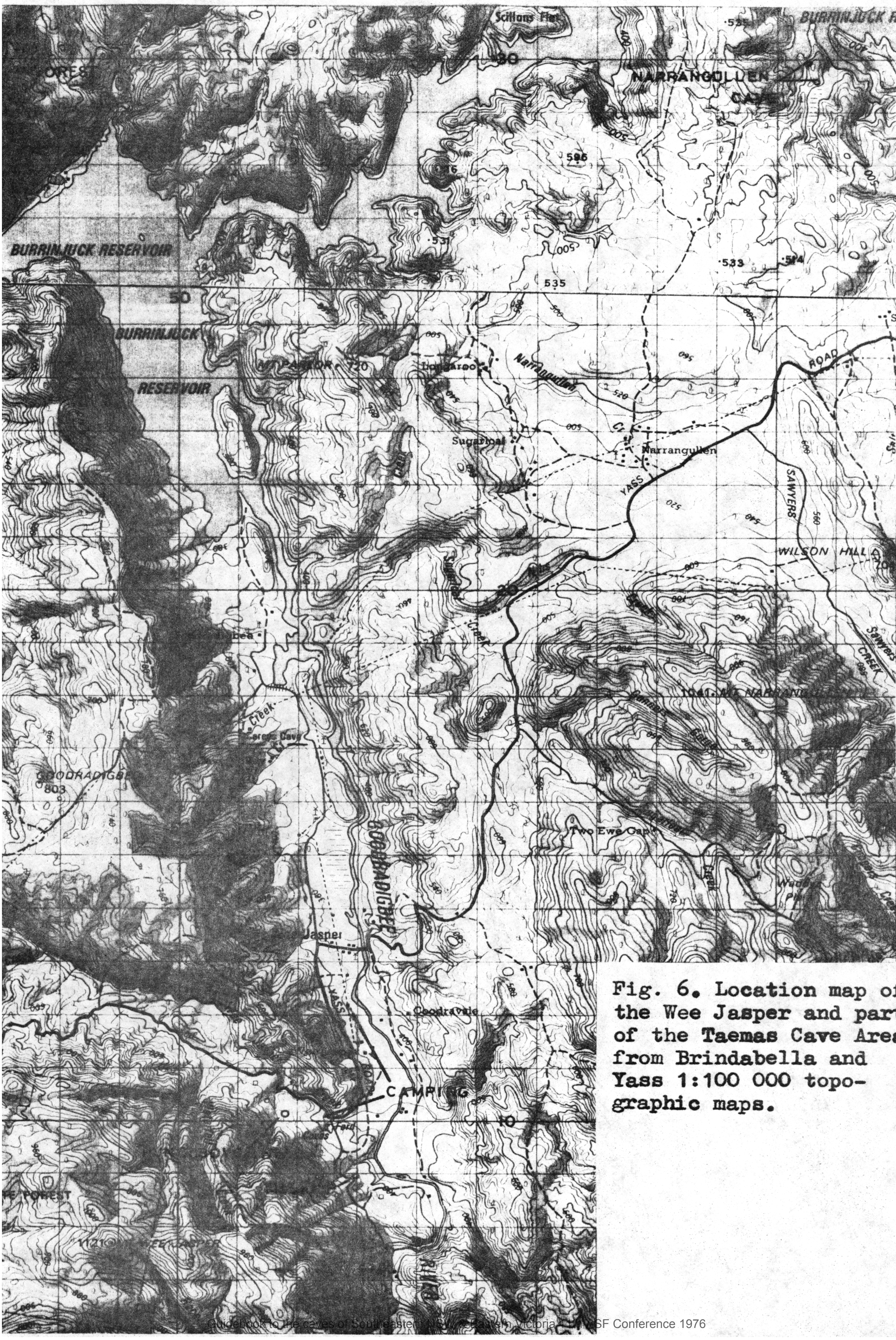
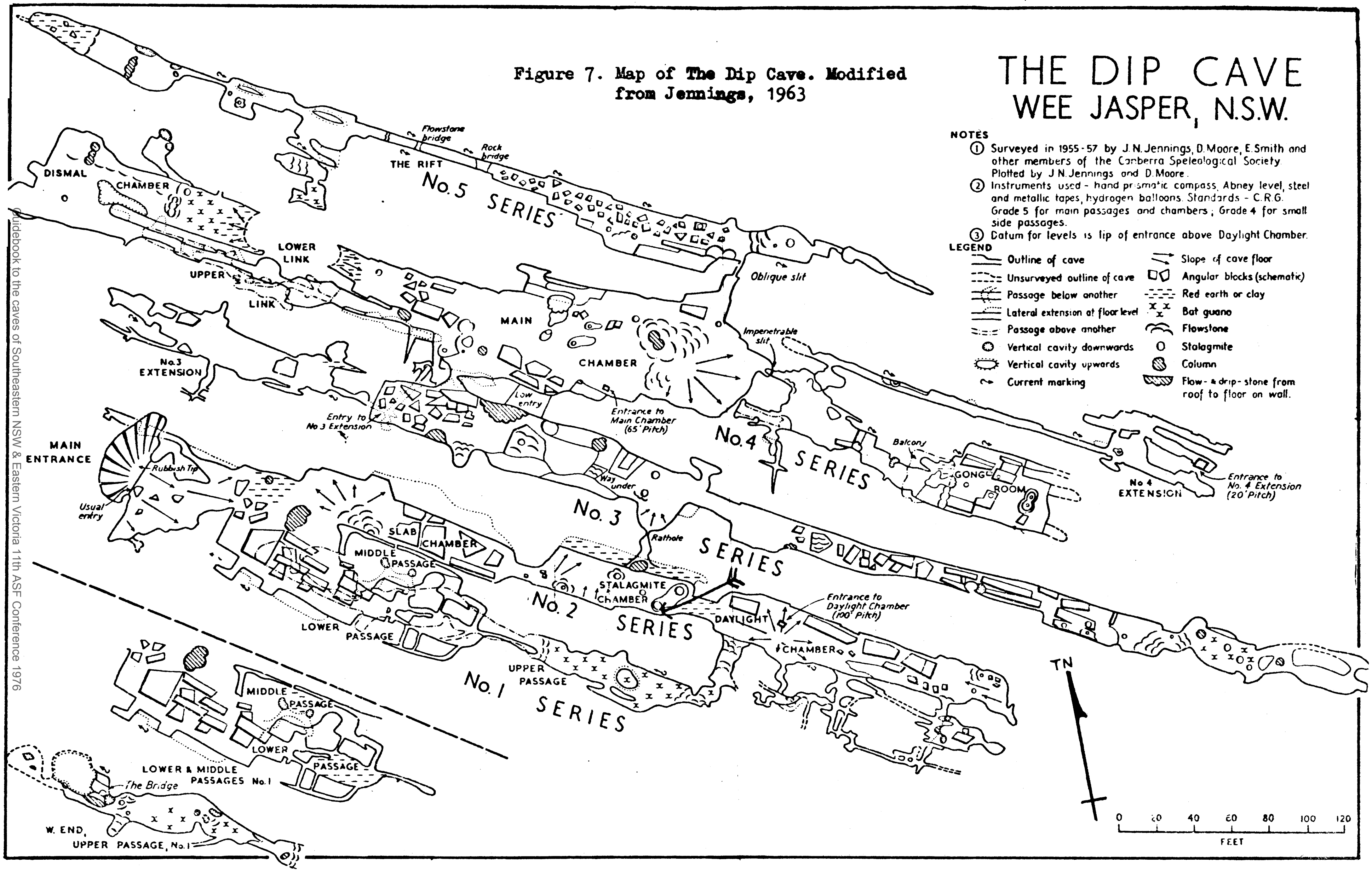


Fig. 6. Location map of the Wee Jasper and part of the Taemas Cave Areas from Brindabella and Yass 1:100 000 topographic maps.

Figure 7. Map of The Dip Cave. Modified from Jennings, 1963



fitted into an area of only 250 m x 90 m with 40 m of relief.

Exploration of the cave is relatively straight forward as reference to the map will indicate. Number 4 Extension cannot be entered from the rest of the cave although there is an impenetrable hole through flowstone to Main Chamber. A ladder or rope is recommended for entry into the Extension for safety reasons. Nowadays entry is usually made through the Main Entrance, used for many years as the local rubbish dump; the rubbish pile has consolidated and moved into the cave and is now much more pleasant than in the past although broken glass still abounds and some care is required. Most of Numbers One and Two Series has been known for many decades and is poorly decorated. The Upper Passage, reached via The Bridge was discovered, with Series Three, Four and Five, in 1955 - 1957. Guano for fertilizing Canberra's gardens was mined from here for some time being winched up through the Daylight Hole which is now much enlarged because of rock fall. The Upper Passage should be avoided during the summer months as it is a possible maternity site for the bent-wing bat, Miniopterus schreibersii.

Access to the rest of the cave is gained by a short climb (arrowed on map) from the Daylight Chamber, across a bridge and then by a traverse along the northern side of the Stalagmite Chamber and thence into the small passage linking the two Series. It is usual for only one or two to make this climb, the remainder of the party ascending by ladder. As an alternative to the free climb this ladder can easily be brought in after a 20 m ladder or abseil drop into Main Chamber. The eastern end of Number Three Series is quite well decorated and occasional bats are found here. Number Three Extension is reached via a descent through a boulder choke, in which mass movement has been recorded, from either the southwestern corner of Number Three or from Main Chamber. This, with Number Four Extension (especially the Gong Room) is the best decorated part of The Dip.

Entry into Number Four Series is also at the western end of Number Three. At the western end of Main Chamber the connection to Dismal Chamber has largely been blocked off by collapse but access can be gained by the Upper and Lower Links. At the eastern end of Main Chamber are the impenetrable connection to Number Four Extension and the route through to Number Five Series. This tall rift-like passage is again quite well decorated in places.

Cave breccias are found in a number of places in The Dip and may contain bones. Several species, some of which are no longer found in the Wee Jasper area, and including the extinct kangaroo Sthenurus sp., have been identified. The only fauna recorded from The Dip are bent wing bats, rats (surprisingly in Main Chamber), snakes and wetas. Examination of the guano piles would certainly result in this list being extended.

The Punchbowl System

Punchbowl (WJ 8), Signature (WJ 7) & Dogleg (WJ 10-16) Caves

Time - Punchbowl 5 hrs. Walking time - 10 min.

Signature 1 hr.

Dogleg 2 hrs+ .

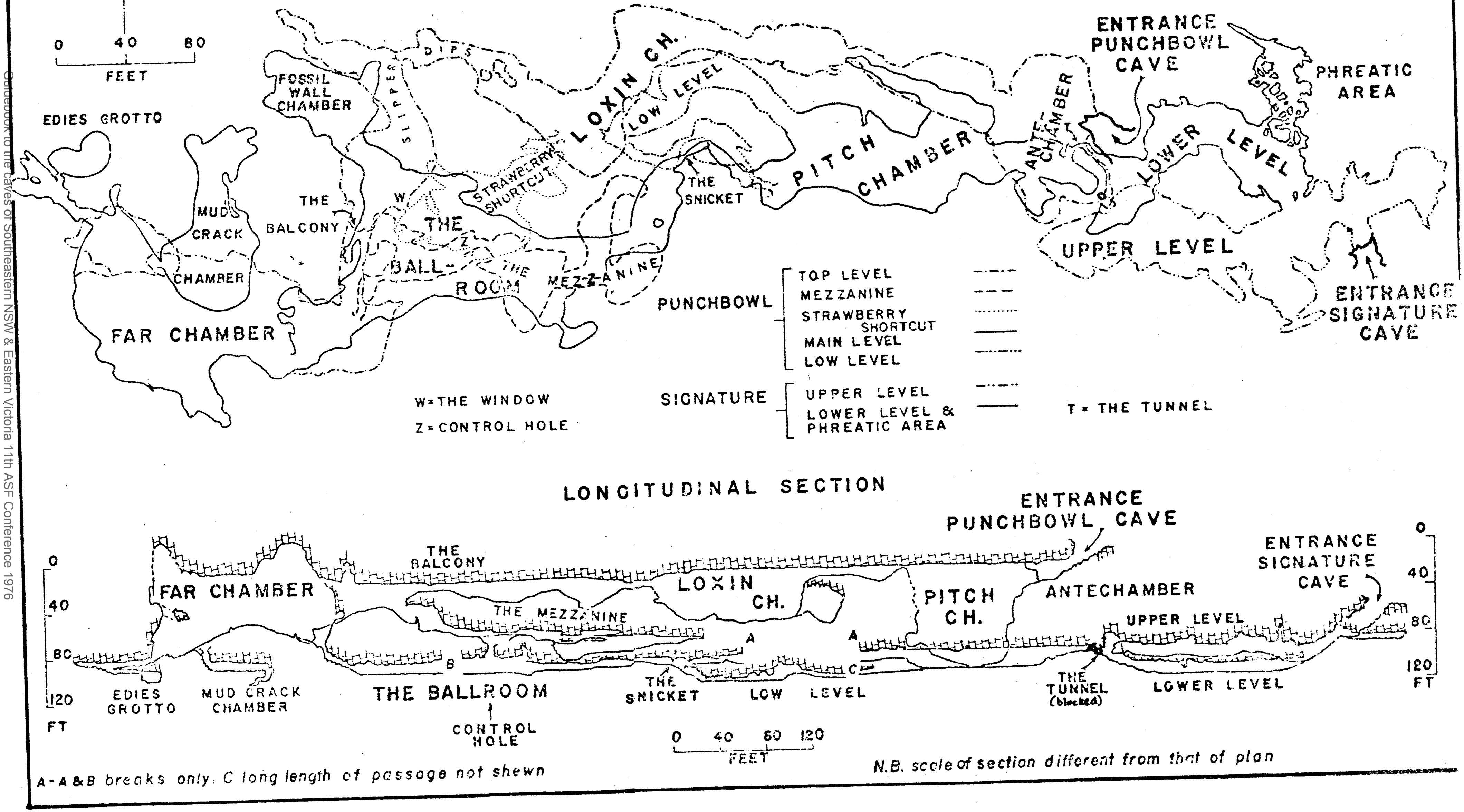
Photography - Good in Punchbowl, limited in Signature and limited to passage shots in Dogleg if only open to the Sand Trap.

Equipment - Punchbowl entrance pitch of 20 m. requires 25 m of ladder and appropriate lengths of rope. Dogleg requires 5 m of ladder and rope on the Opera House wall.

PUNCHBOWL AND SIGNATURE CAVES

WEE JASPER N.S.W.

Figure 8. Map of Punchbowl and Signature Caves. Modified from Jennings, 1964.



References -

Jennings, J.N., 1963, Collapse Doline, Australian Landform Example No. 1, Aust. Geogr., 9 : 120-121.

" " 1964, Geomorphology of Punchbowl and Signature Caves, Wee Jasper, NSW., Helictite, 2 : 57-80.

" " 1971, Some Karst Areas in Australia, in J.N. Jennings and J.A. Mabbutt (eds.), Landform Studies from Australia and New Guinea, ANU Press, Canberra, 2nd ed.

The Punchbowl system (G.R. 519410 Brindabella 1:100,000) is situated about 4 km south of Wee Jasper village. It is a far more complicated system than The Dip cave and consists of Punchbowl - Signature - Anemone Caves and the present stream level Dogleg Cave. The cave has developed in seven stages, four periods of epiphreatic and three of vadose development have been demonstrated and the interested reader is referred to Jennings (1964) for an outline of the development. It has considerable geomorphological, biological and sporting interest. The cave is found in a reef mass within the Taemas Limestone, little structural control is evident. In 1957-58 a tunnel was excavated through a rockfall to provide a connection between Pitch Chamber in Punchbowl Cave and the Lower Level in Signature Cave. The tunnel was blocked in 1966 in an attempt to reduce visitor levels and vandalism in Punchbowl.

A well beaten foot track leads from near the outflow of Dogleg Cave (G.R. 521310) to the entrance of Punchbowl Cave passing over Anemone Cave (two entrances to a small insignificant cave previously an outflow cave for the system) and passing the entrance to Signature Cave which will be described separately below. From The Antechamber a 20 m pitch descends to Pitch Chamber, a large flowstone column provides an excellent belay point. This chamber as far as The Snicket was explored in 1936 after a young woman had fallen from the Antechamber. She was rescued, without injury, by rescuers using long tree trunks to gain access! False floors were intact beyond The Snicket when first entered in 1956. Opening below here is the lowest level of Punchbowl, some fine roof pendants are found, and after a tight crawl one can emerge into Pitch Chamber again. Beyond The Snicket one goes through a fine elliptical passage formed under hydrostatic pressure and enters The Ballroom. In the centre of this chamber in the roof is the Control Hole leading up to the Mezzanine, to the northwest is Fossil Wall Chamber in which is exposed the underside of a richly fossiliferous limestone bed. At the far end of The Ballroom one climbs up onto the talus slope of Far Chamber. This is the only room in Punchbowl - Signature without a stream cut roof. Downslope leads to Mudcrack Chamber and the Diprotodon Pit. In the northwestern corner of Far Chamber is a crawl into Edies Grotto which is well decorated, at least by Punchbowl standards.

Just above The Ballroom - Far Chamber link is a steep slope leading to the upper levels of the system. From the top of the slope one descends into the Mezzanine level and the top of the Control Hole; the route lies to the right of the Hole with a short jump up opening out at the base of a flowstone slope in a low chamber. From here the best route is to the left up the slope to The Window. A short traverse leads down to the Balcony from which one obtains a view back toward Far Chamber. In the incised canyon below The Window is the Laundry Chute, a rope or ladder should be used for the descent as the drop at the bottom (about 1.7 m) is surprisingly difficult. The small room opening from the bottom of the Chute was formerly floored with impressive crystalline pool deposits, of which a few remnants can be seen. These had been so vandalised by the early 1960s that it was thought justified to remove some material for museum storage.

To the north of the Window the route to the Loxin Chamber is via the Slippery Dips. Just beyond the foot of the last slope on the right hand wall is a "doorway" that leads to the Strawberry Shortcut. This crawl is the usual way out and leads to the jump-up at the Control Hole. In the eastern end of the Loxin Chamber is a flowstone slope with the loxins (rawlbolts) with which the climb was first made although it can be climbed free. From the top to the right is Shawl Corridor and to the right is a hole through which one can look across the top of Pitch Chamber to the Antechamber. Abseiling from here completes the trip but usually the party retraces its steps via Strawberry Shortcut.

Signature Cave corresponds with the lower levels of Punchbowl. From the foot of the entrance slope take the lower passage; a few metres along on the right hand side are a few small holes leading into the Phreatic Area. At the far end of the lower level is a boulder choke through which the Tunnel, now blocked, was excavated. Just back from here is a hole leading up to the upper level, to the right at top are some large rimstone pools, unfortunately badly vandalised and very dirty. Following the passage to the right leads back towards the entrance. Signature Cave was named because of the abundance of names on walls and roofs, some of these date well back into the 19th Century.

Dogleg Cave is the lowest level of the system and is intermittently active. The cave can be entered for a few metres at a number of points (WJ 10-12) between the rising and the main excavated entrance (WJ 13,14) and at two points (WJ 15,16) between the entrance and the Lake Chamber. From the main entrance a crawl of about 200 m leads through meandering elliptical passages typical of epiphreatic flow to the Lake Chamber. The remainder of the cave is only accessible after prolonged dry weather; after the lake dries out a steeply descending tube known as the Sand Trap leads to the Opera House. Climbing a steep slippery wall leads to the Second and Third Watertraps and ultimately to the remainder of the cave. The far end has been shown by rough traverse to be very close to the intermittent creek beyond the Punchbowl doline. Most of the cave is developed at stream level except for some high levels beyond the Third Watertrap.

From a biological point of view the Punchbowl system is most interesting. It is the type locality for at least three arthropods, one of which, an isopod from Dogleg, is one of Australia's few troglobites. The bat-fanding scheme was started in 1957 with bent wing bats in Punchbowl and relatively large numbers of bats still roost in the cave in spite of the high visitor pressures. Bones, from fine sediments not breccias as in The Dip, have been dug from the floor of Mud Crack Chamber and from Pitch Chamber. The most significant discovery was part of the skeleton of the extinct marsupial diprotodontial, Nototherium sp. which resembled a giant wombat.

Before leaving Punchbowl hill the dolines on the saddle about 350 m WSW of Punchbowl Cave entrance should be visited. The smaller round bottomed doline is The Punchbowl. The talus slope in the large collapse doline continues through into Far Chamber but the connection is blocked. Beyond these two is a spectacular conical doline on the contact between the limestone and the Goolarragandra Volcanics. The steep gully and its intermittent stream beyond here were responsible for the formation of the cave system.

TAEMAS & WARROO AREAS

The Taemas and Warroo Cave Areas are located on the west and east sides, respectively, of the Murrumbidgee arm of Burrinjuck Dam. Prior to flooding of the lake the two areas would have been considered as one. Geologically both areas have caves developed in limestone of Early Devonian age, with some interbedded shale and siltstone.

Compared to the Wee Jasper Area, relatively few caves have been found in the Taemas and Warroo Areas. This may in part be a reflection of the limited intensive surface exploration of these areas as compared with Wee Jasper. Most of the caves are relatively small and only the largest, Narrangullen Cave, is described.

To minimize inconvenience to the land-owner only a limited number of trips to Narrangullen Cave will be organized. However the cave can be reached at any time by boat. It is a round trip of 22 km from the Good Hope Caravan Park where boats may be rented. Because many fishermen use the facilities, booking arrangements should be made well in advance. Bookings can be made by phoning Mr Jack Thompson on Yass 27-1234. Boats hold 4-5 people and will cost about $12/day.

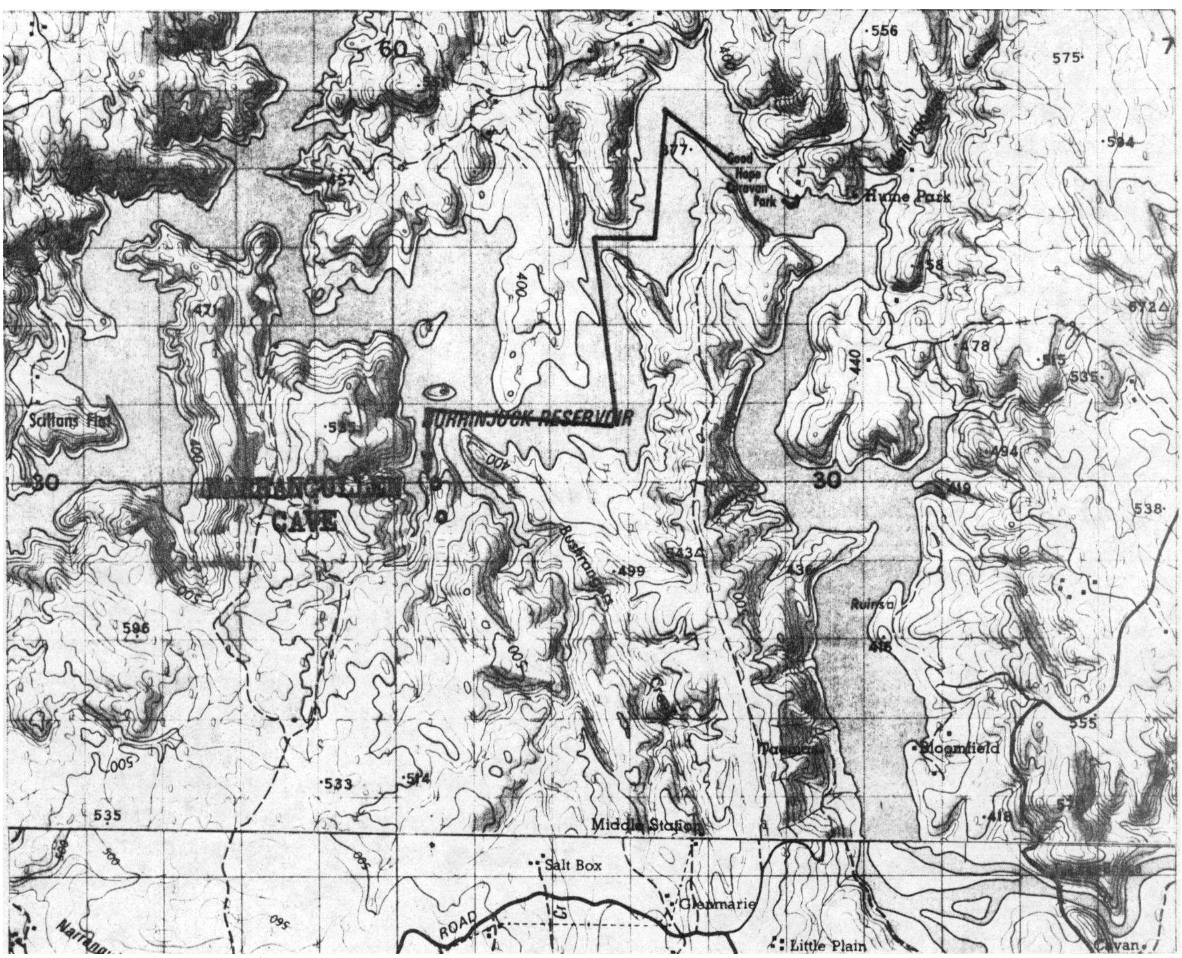


Fig. 9. Location map of the Taemas and Warroo Cave Areas. From Yass and Brindabella 1:100 000 topographic maps.

Narrangullen Cave (TM 1-3)

Time - 2 hrs Walking time - 10 min to upstream ent.
20 minute to downstream ent.

Photography - large passages

Equipment - none

References - Counsell, W, 1971, Spar 11, 6-9.
Wood, I, 1972, Spar 16, 17-20.

Narrangullen cave is the largest cave in the Taemas and Warroo areas. It is an intermittent stream cave developed along a synclinal axis in tightly folded limestone. On the shores of Burrinjuck Dam, it can be reached either by boat from Goodhope, or by driving in through Narrangullen property. It is a mostly spacious stream cave accessable at both ends. Due to a number of sumps, a through trip is not possible, except perhaps in periods of extreme drought.

The main entrance at the upstream end (TM-3) is a narrow slit on the hillside a few metres above the end of the blind valley which supplies water to the cave.

A steep slippery (when wet) mud slope extends down from the entrance to some breakdown material, at the base of which the stream is met. The stream is then followed by boulder hopping to a large high roofed chamber which has a measured roof height of about 52 metres. This area of the cave is often occupied by bats (Miniopterus schriebersii).

The stream sumps at the end of this chamber, but fortunately there is a dry by-pass up the steep muddy slope on the left hand side. Near where the stream is again encountered are some impressive gours. Unfortunately though they are rather dirty and damaged.

From here the stream widens into a large shallow lake that covers almost the entire floor area of the triangular-shaped passage. At the far end of this lake, the passage widens, roof height increases and the stream sumps in a couple of pools on the right hand side. A small blind passage continues for a further 30 metres on the left hand side.

The large entrance TM 1 to the downstream end of the cave is about 600 m over the hill from the blind valley. It is under some thickly bedded limestones at the end of a cove and is a few metres above maximum lake level.

Passage dimensions of this end are generally smaller, and apart from a side chamber near the entrance, the cave is basically a flat, sand and mud floored passage with a shallow meandering stream channel.

NARRANGULLEN CAVE
(TM 1,2&3)

Surveyed by UNSWSS 1971-72.
North and south sections CRG6
Central section CRG4D
Map adapted from SPAR 16:p.19.

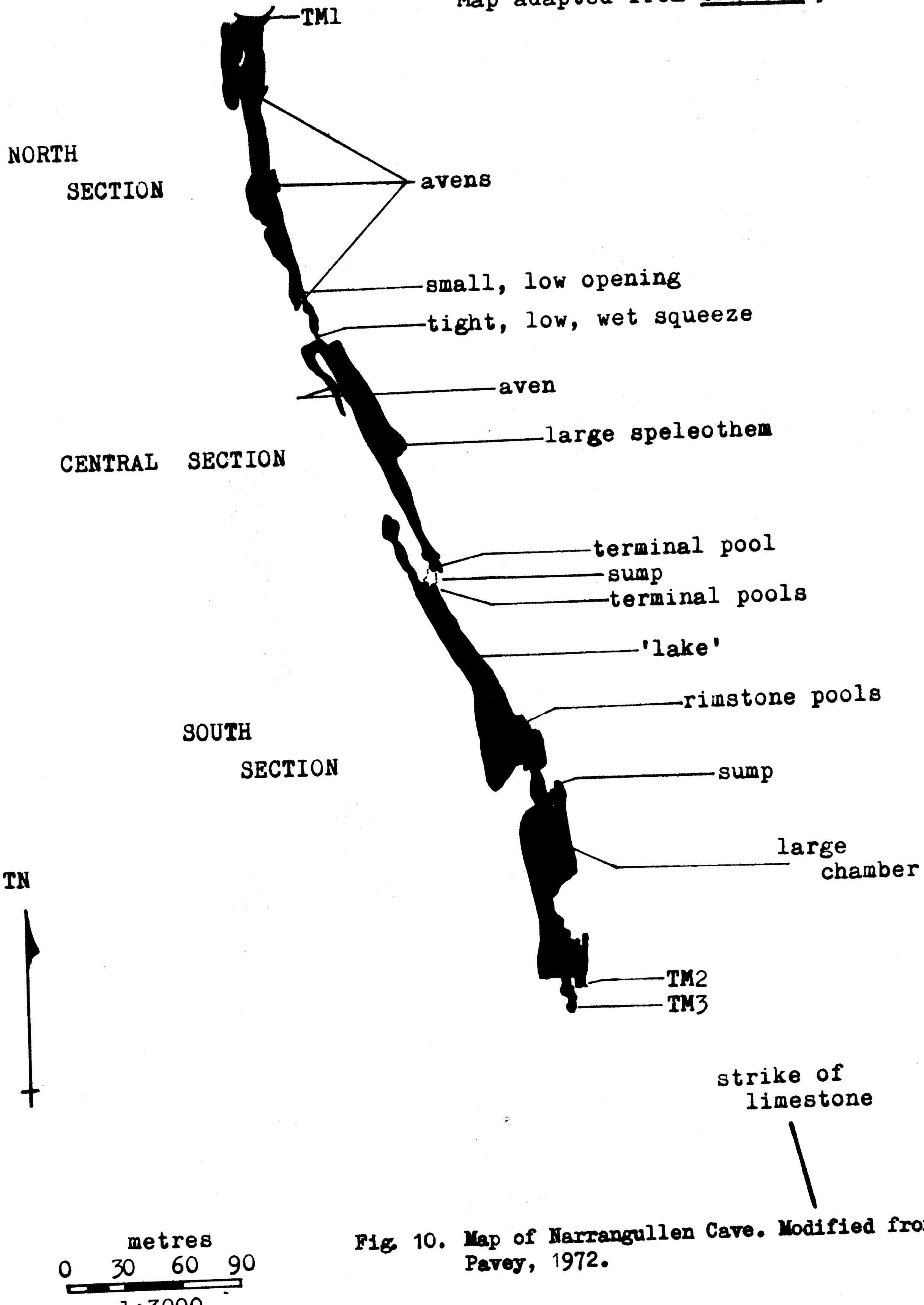


Fig. 10. Map of Narrangullen Cave. Modified from Pavey, 1972.

About 160 metres from the entrance there is a small opening at floor level in the eastern wall. If the stream is flowing, this opening will be (almost) completely under water. If passable it gives access to a low narrow passage near the end of which is either a low muddy crawl, or a sump, depending on water level. Beyond this constriction the cave opens out again into the final chamber. The pool at the end is the final sump and is only a few metres from the terminal pool in the upstream end.

Although rumoured to have been negotiated by locals during drought periods, the only definite connection was made by an UNSWSS diving party a few years ago.

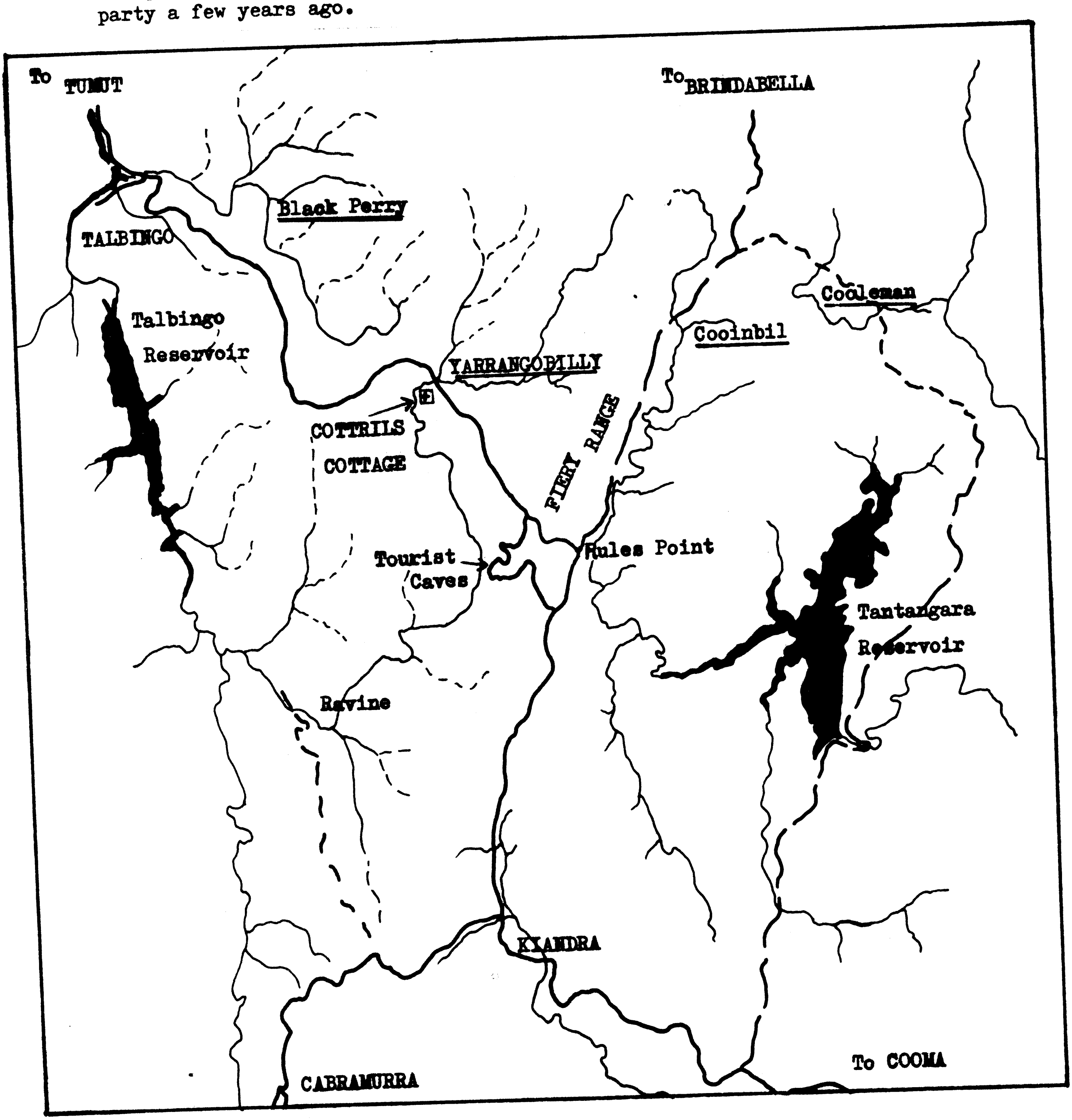


Fig. 11. The Fiery Range Karst Region.

FIERY RANGE KARST REGION

There are four limestone units in the Fiery Range Karst Region, that have well developed karst features. Two of these areas, Yarrangobilly and Cooleman Plain are relatively well known and have good cave development. The other areas, Cooinbil and Black Perry are small and generally not well known. The four areas provide some interesting contrasts - in terms of geology, topography and karst features - in this highest karst region of eastern Australia, (fig. 11).

Yarrangobilly has an elevation of about 1100 m with 200 m of relief in the Yarrangobilly River Gorge that transects the area. Limestone outcrops for about 10 km along the river. Cooleman Plain is about 1260 m elevation and locally has up to 100 m of relief along Cave Creek. Cooinbil is at an elevation of 1360 m with less than 10 m of relief. Black Perry has an elevation of 900 m and about 100 m of relief.

All the limestones are of Silurian age. Cooinbil is of Early Silurian age while the rest are of Late Silurian age. Dip of the beds is variable in all areas but is generally steeper at Yarrangobilly and Black Perry than Cooleman and Cooinbil. Only the Black Perry area has been extensively metamorphosed, by a granite intrusion, but there has been minor mineralization at Yarrangobilly (copper) and Cooleman Plains (lead, zinc).

Cooinbil lacks any real cave development but has many solution features and the streams are 'almost underground' at several points. Black Perry has yet to be thoroughly investigated but is known to have small caves in addition to the fact that Clive (Cave) Creek flows underground for about 1 km.

Cooleman Plain, with its low relief, is characterised by horizontally developed caves and generally, has vertical drops of only a few metres. Yarrangobilly with greater relief, has a greater component of vertical development than Cooleman Plain but less than areas such as Bungonia, NSW. Typically at Yarrangobilly there is a steep descent at or near the cave entrance followed by generally horizontal passage development. Streams entering the caves near the limestone contact rise as springs or cave streams along the Yarrangobilly River.

Accommodation and Provisions

Camping is available at Long Plain Hut, Blue Waterholes and Yarrangobilly village. Cottrils cottage will be used as the area coordination centre and will not be used for sleeping accomodation (i.e. bring a tent). Some provisions and petrol can be obtained at Cabramurra and Talbingo, but major supplies should be obtained in Canberra, Tumut or Adaminaby before reaching the area. There will be no water problem if it is a normal year but in a dry year water may be in short supply in some parts of the area. Remember that the Kiandra Pub is closed - no beer, no petrol.

BLACK PERRY CAVE AREA

The Black Perry Cave Area is located along Clive (Cave) Creek and around Black Perry Mountain. The area is 8 km east of Talbingo and 3 km north of the Snowy Mountains Highway. Access is by a steep climb down from the highway or by 4 wheel drive vehicle along fire trails. These are normally closed and special permission must be obtained to drive into the area.

Clive Creek has cut a deep, narrow valley into limestone of Late Silurian age. The eastern margin of the limestone is marked by a belt of skarn rock and much of the adjacent limestone should really be termed a marble because it is recrystallized.

The Black Perry area has not been explored in detail but Clive Creek is reported to flow underground for about 1 km. At least one of the tributary creek sinks along a joint plane after crossing onto the limestone and there is some extensive lateral cutting forming benches in cliff faces along Clive Creek near the west edge of the limestone.

The area is described here to encourage a couple of trips of exploration into one of our "unknown" areas.

COOINBIL CAVE AREA

The Cooinbil Cave Area is located on Long Plain about 12 km north of Rules Point. It is reached by following the Long Plain Road until it crosses the Murrumbidgee River and then turning right onto the track to Cooinbil homestead. Caution - do not drive off the track - save the snowgrass!

The Cooinbil area consists of a number of small isolated limestone lenses that appear to be set in shale. A number of different types of limestone are found, but the most prominent is white and red coloured. The area is drained by three small streams that have cut into the limestone.

By any definition there are no caves developed at Cooinbil. However there has been much limestone solution and in several places the streams are effectively 'underground' for several meters. These and the well developed grikes make this an interesting 'cave' area.

COOLEMAN PLAIN CAVE AREA

The Cooleman Cave Area is located on Cooleman Plain, about 60 km SW of Canberra. Cooleman Plain is a broad valley developed on the Cooleman Limestone. The Plain at an elevation of 1260 m is almost completely surrounded by hills that rise 100 to 200 m above the limestone. The plain is drained by Cave Creek which follows the arcuate shape of the plain and then flows eastward to join the Goodradigbee River.

The northern part of Cooleman Plain, that part north of the abandoned Coolamine Homestead, has very low relief, is mostly soil covered, and only a couple of small caves are known. The southern part of the Plain contains the bulk of the caves with the exception of those located along the thin slivers of limestone along the lower part of Cave Creek and the Goodradigbee River.

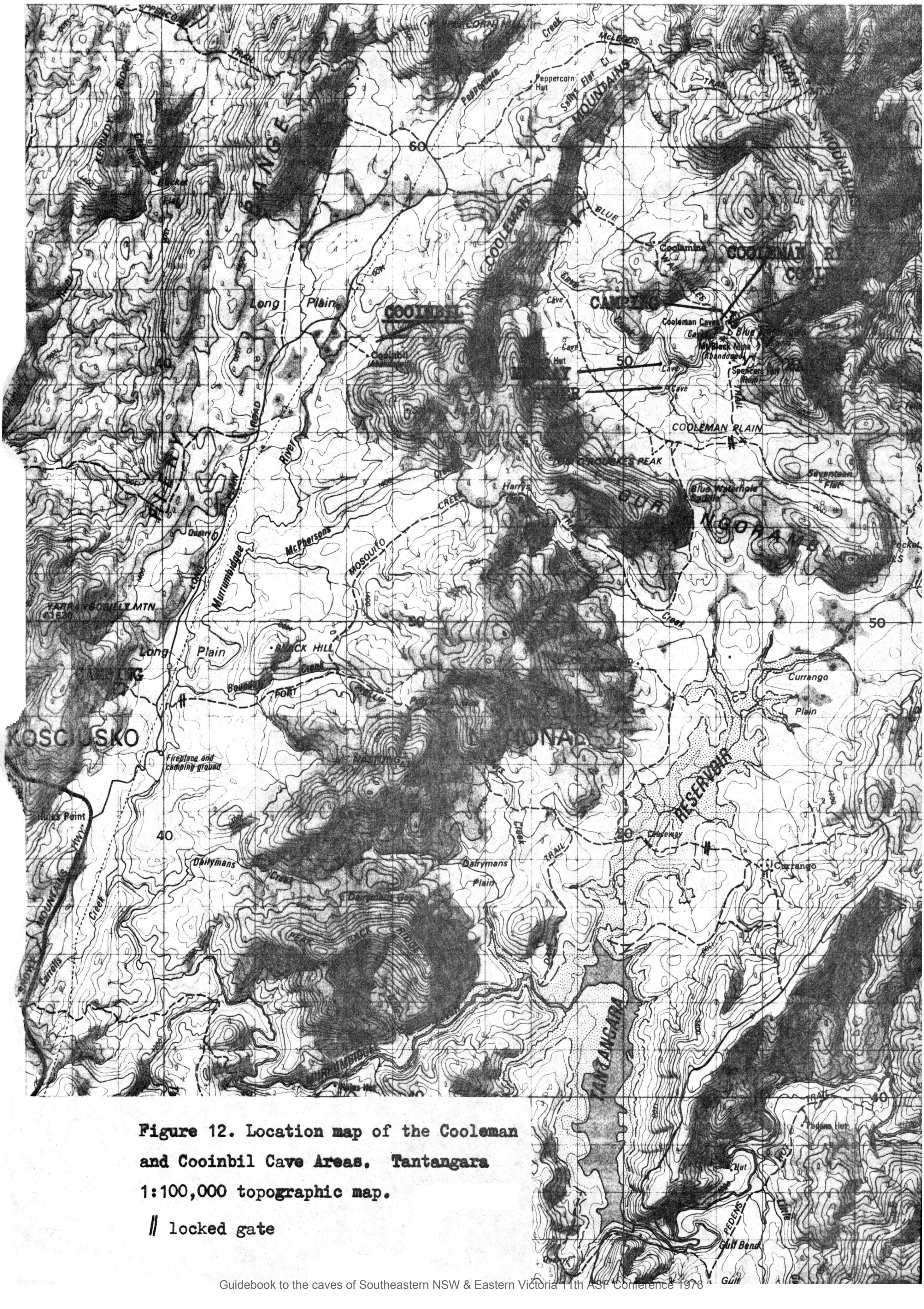


Figure 12. Location map of the Cooleman and Cooinbil Cave Areas. Tantangara 1:100,000 topographic map.

// locked gate

The Cooleman Plain caves may be generally described as short, clean and cool. Seldom is found the choking dust or glutinous mud which abound in most other caving areas. Instead, these short but adequate caverns provide experiences of clean scalloped limestone, fresh river gravel, and cool underground streams.

Vehicular access to some parts of the plain has been prohibited in recent years, but the short walks to the cave entrances are through some of the most beautiful alpine grassland in New South Wales.

Cooleman and Right Cooleman Caves (CP 1,2)

Time - $1\frac{1}{2}$ hrs. Walking time - 10 min each way.

Photography - limited

Equipment - none

Reference - Jennings, J.N, 1970 Helictite V8(4), 91-99.

A through trip in what was once the outflow passage of the underground drainage which now rises at Blue Waterholes. Both caves provide sections of wide, but fairly low passage, which are decorated with roof pendants, leading to larger breakdown chambers. The connecting squeeze between the two caves was first forced in 1964 when C.S.S. eventually found a member sufficiently slim in girth and intellect to give it a try.

A phreatic labyrinth of tubes exists near the connection and early trips (1957-1962) spent time trying to locate a reported 'deep rift' in this area. If such a rift was found, it might give access to the master cave system which now carries water to the Blue Waterholes rising.

Barbers Cave (CP 14-17)

Time - 1-4 hrs Walking time - 15-20 min each way.

Photography - interesting passage shots, some speleothems.

Equipment - hand line

Reference - Jennings, J.N. 1968, Helictite V 6 (2), 23-29.

Located in the wall of the gorge, downstream from the Blue Waterholes campsite, this cave contains a wide variety of caving experiences with the exception of pitches.

There are no fewer than six negotiable entrances stretching from river level to the stream influx at the top of the gorge walls.

There are still several speleothems worthy of admiration and the exit route through the lowest entrance (with the creek for compass) is sure to refresh even the most tired of cavers.

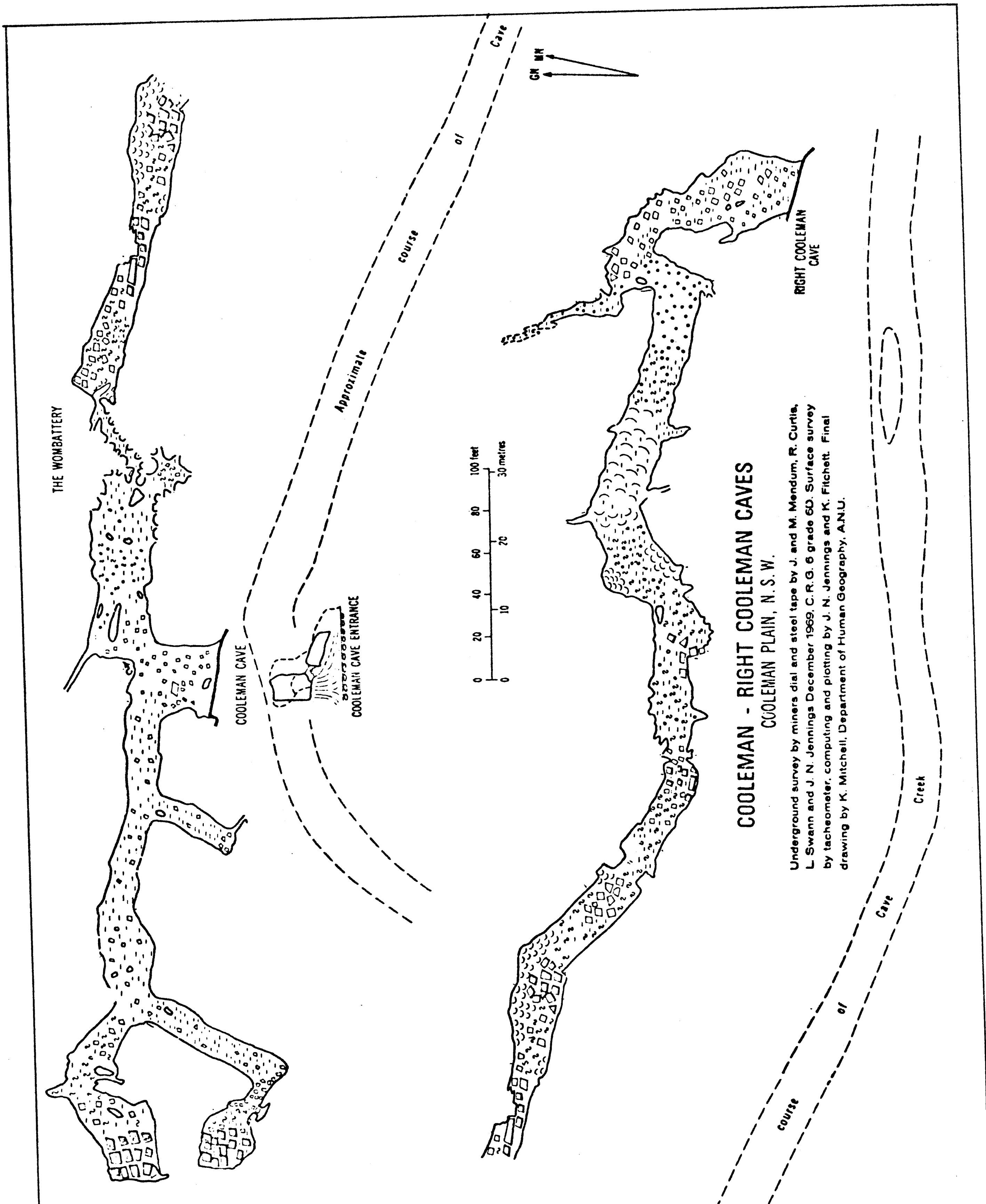
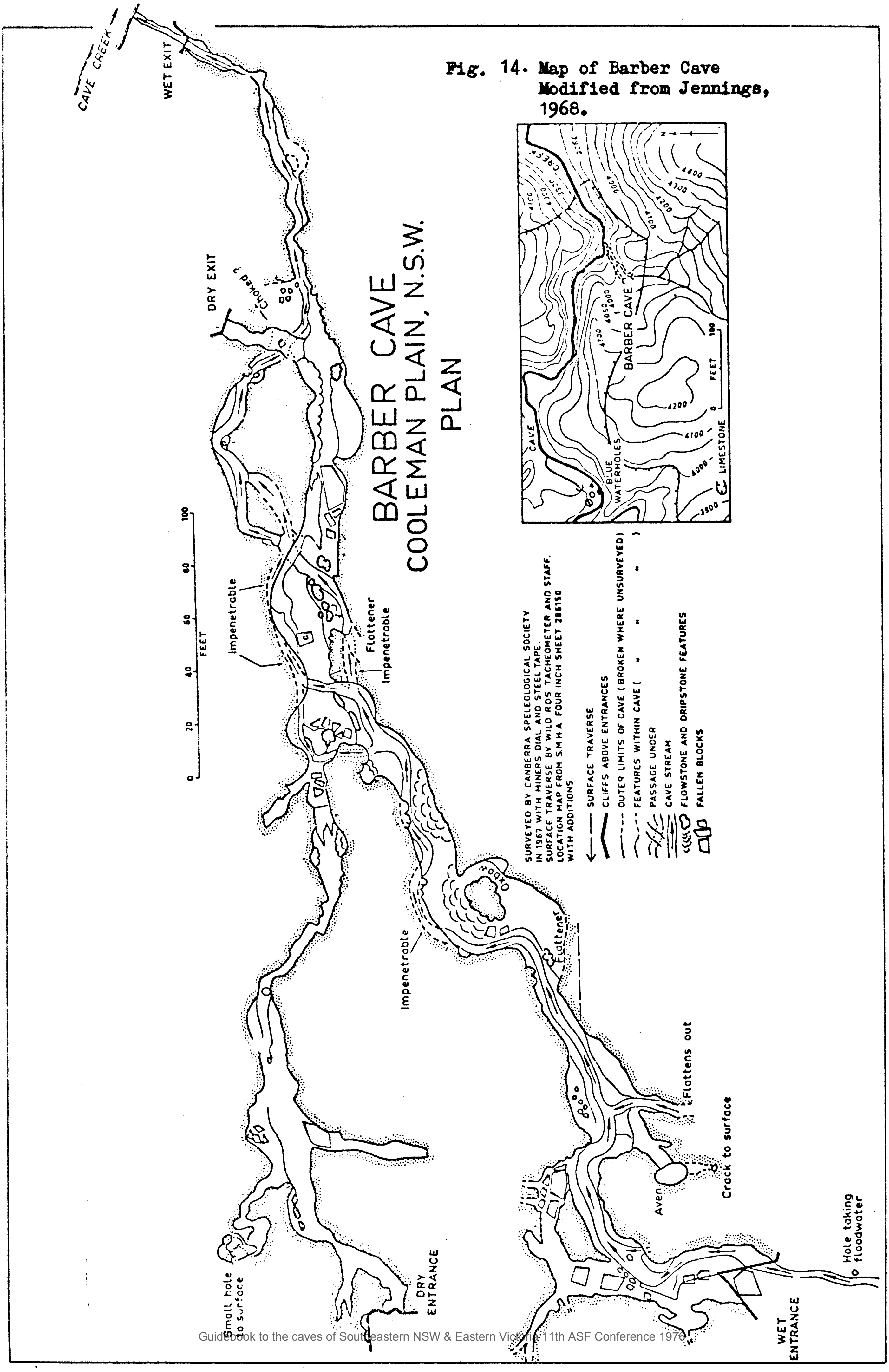


Fig. 13. Map of Cooleman and Right Cooleman Caves. Modified from Jennings, 1970.

Fig. 14. Map of Barber Cave
Modified from Jennings, 1968.



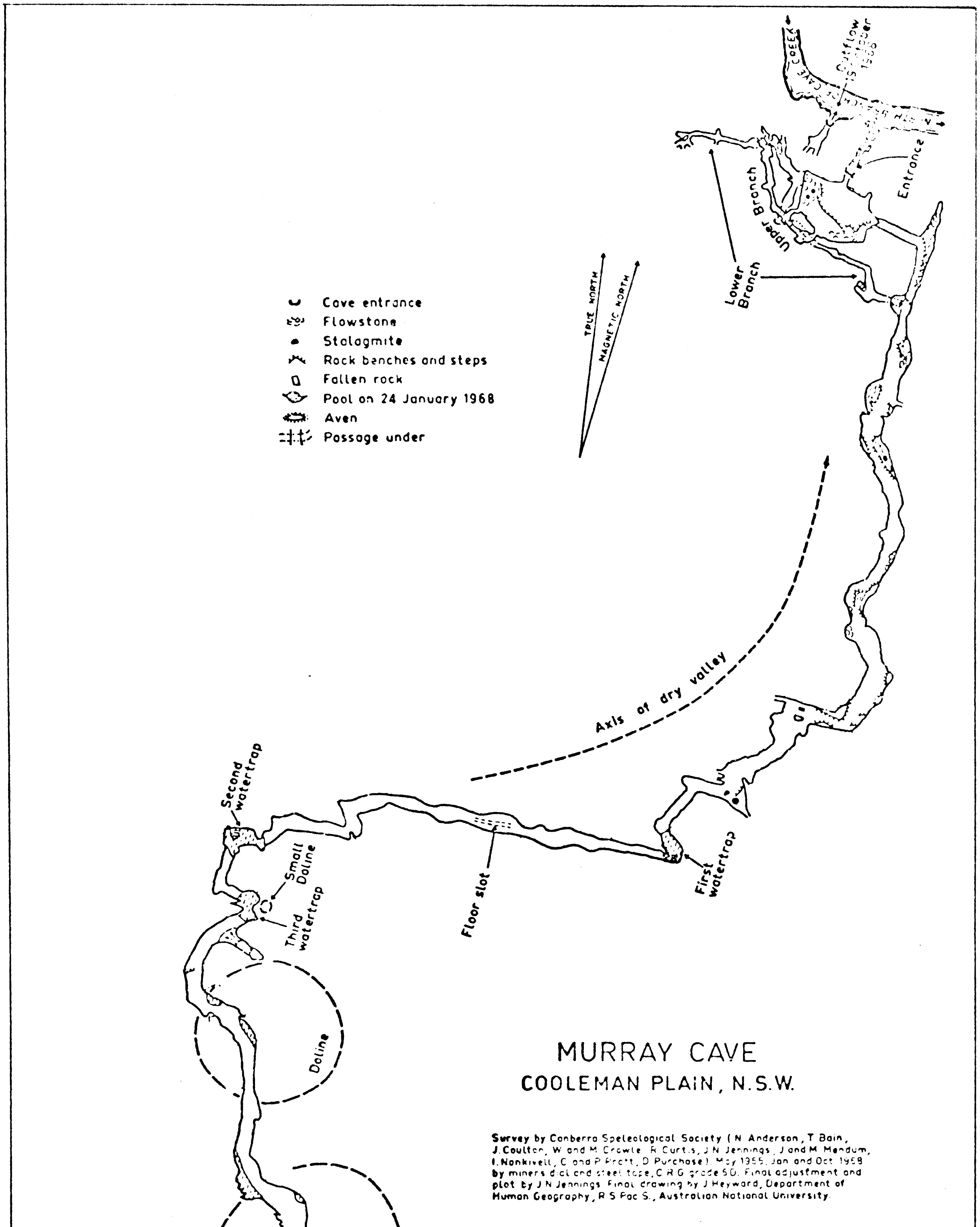


Fig. 15. Map of Murray Cave Modified from Jennings and others, 1969.

Murrays Cave (CP 3)

Time - 1 hr Walking time - 40 min each way

Photography - good example of vandalism, some regrowth

Equipment - none

Reference - Jennings, J.N. et al. 1969 Helictite v. 7 (2), 23-38.

Situated in the gorge upstream from Blue Waterholes. A fairly level intermittent stream passage of large proportions, which requires little caving technique or equipment, leading to a large sump some 1200 feet from the entrance.

Vague rumours of the sump drying up during the great drought of 1905-1906 were proved factual in 1967 when access was gained through the dry sump to a further 1300 feet of cave which contained signatures dating from the earlier opening.

The cave's speleothems are a good example of cave recovery since some of the better specimens were removed to grace the gardens of the Queanbeyan gentry in the early part of the century.

River Cave (CP 6)

Time - 1½-3 hrs Walking time - 45 min each way.

Photography - passage shots

Equipment - flotation gear if river passage followed upstream.

Reference - Jennings, J.N., 1969, Helictite v. 7 (4), 69-84.

This cave is the final underground viewing point of the Cave Creek South Branch between the stream sink and its reappearance at the Blue Waterholes rising.

The obvious entrance is located in the side of a dry valley not far from the South Branch Gorge. The initial high rift-like entrance passage crosses a few permanent seepage pools and shrinks to a stony crawl. Depending on seasonal conditions the caver can sometimes expect to wade in a crouched position through a pool caused by the build up of seepage in the passage.

The river for which the cave is named, can be heard for some time before it is reached and it flows on a bedrock and gravel bed through a classic passage ranging from 1.5 to 12 metres in height.

The upstream section requires some deep wading, then swimming and terminates after 12 m in a sump.

The downstream passage is blocked by a siphon of some 3 m in length which has in recent years been fitted with a nylon guideline. The sump is wide, shallow, has no obstacles, and the water temperature can only be described as refreshing.

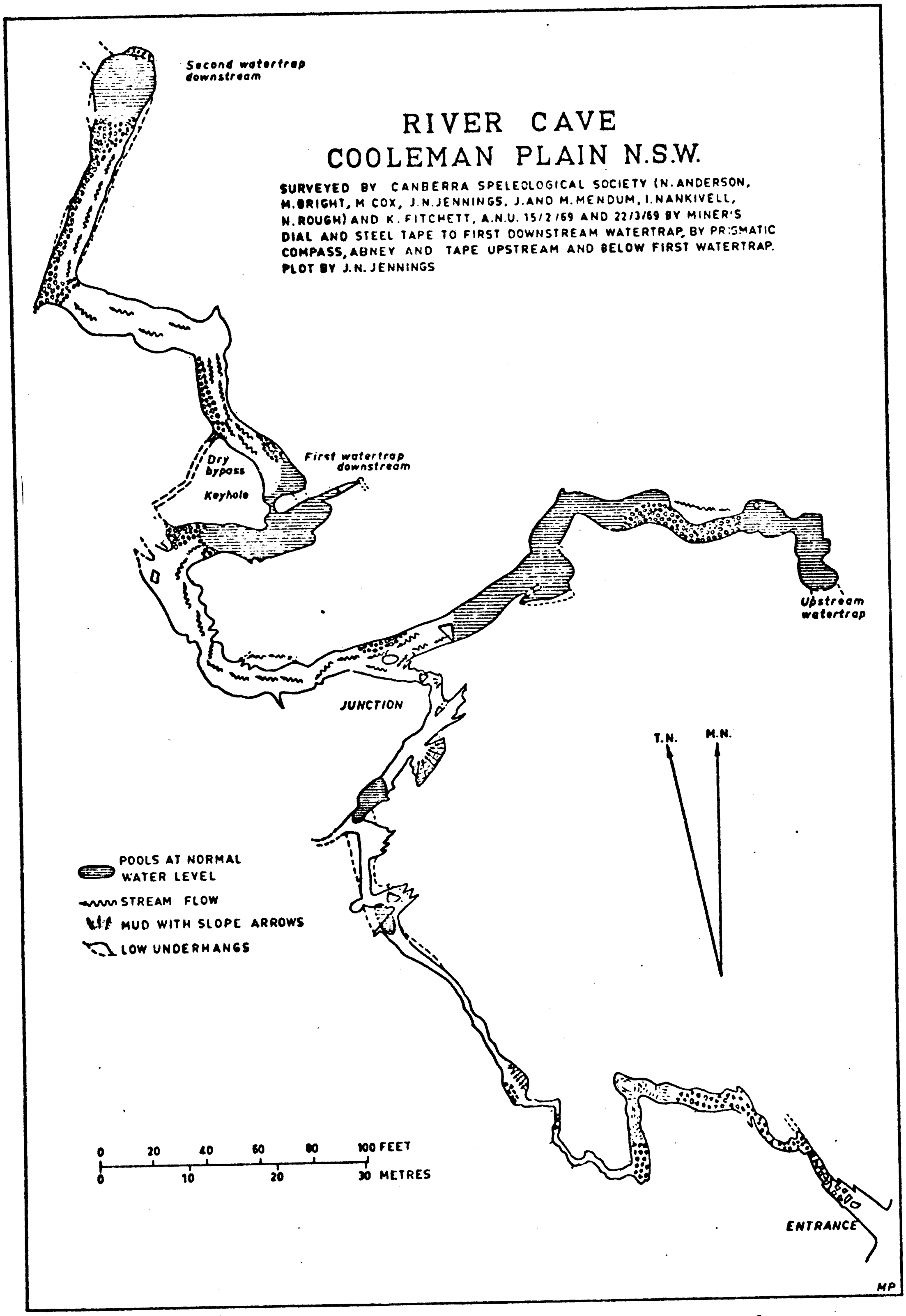


Fig. 16, Map of River Cave. Modified from Jennings, 1969.

Beyond the sump the stream passage continues in a similar vein before ending in a high roofed chamber which contains the 'final' sump (for non divers) which was dived by a joint C.S.S. - South Pacific Diving Group trip in 1968 and yielded a further 250 m of passage terminating in yet a further sump.

In brief an invigorating trip regardless of weather conditions.

YARRANGOBILLY CAVE AREA

The Yarrangobilly Cave Area is located along the valley of the Yarrangobilly River in the northern part of the Kosciusko National Park. Access to the area is by way of the Snowy Mountains Highway from Cooma or Tumut. The caves are developed in the Yarrangobilly Limestone of Silurian Age.

The Yarrangobilly River has deeply entrenched itself in the southern part of the area where limestone cliffs may be more than 100 m high and local relief from the limestone plateau to the river is about 200m. In the Village area the river is entrenched only a few meters.

The entrenchment of the river has meant that the active stream caves also quickly seek the river level. Thus caves along the eastern margin of the limestone are characterized by steeply descending collapse filled initial passages and horizontal or near horizontal lower passages. The Eagles Nest System (Y1-3) is typical of these caves. This cave system, the largest in the area is the deepest cave (174 m) on the Australian mainland.

Eagles Nest System, (Y1-2-3)

Time: 5-10 hrs.

Walking time: 20 min each way from parking site.

Equip-ment: 9m ladder, ropes may be handy in the West Eagles Nest pitch (Y1).

Keys from rangers to locked gates in system.

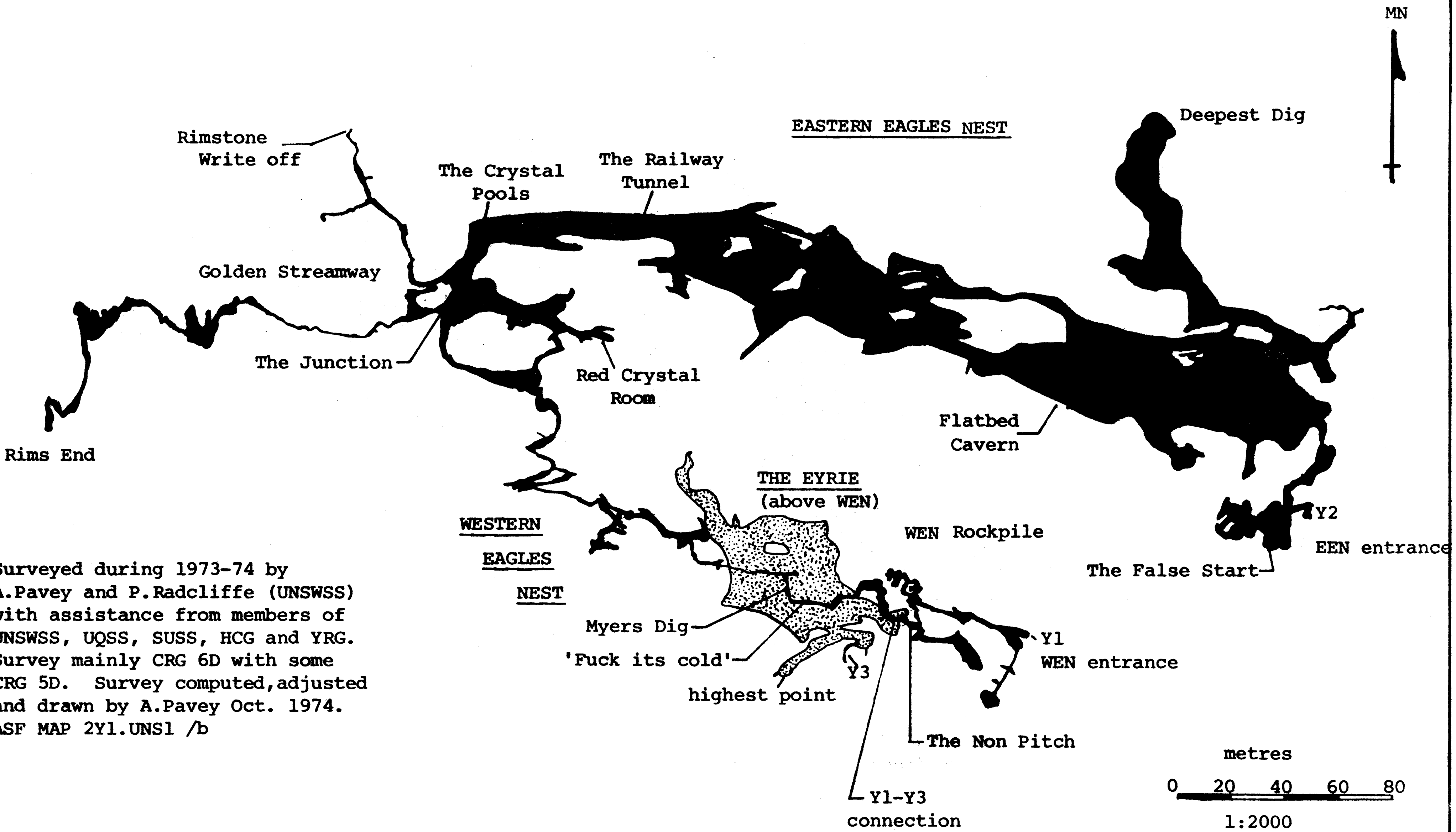
Photography: excellent in parts.

Reference: Pavey, A. 1974. Spar 40, 2-39. (Also part reprinted in ASF Newsletter 65, 3-6, 1974).

The caves at Yarrangobilly were first discovered in 1839, but the Eagles Nest System was not discovered until 1950 and first explored in 1951. By the late 1950's, most of the currently known system is believed to have been discovered. It wasn't until the cave was mapped in 1974 by UNSWSS that the true extent of the system was realised.

The Eagles Nest blind valley is second only to that of Rules Creek in size at Yarrangobilly, but is more impressive due to the terminal wall being approximately 30 m high. The situation of the Eastern and Western caves is a classic example of stream piracy, with the stream now sinking in the Eastern cave. The Western Eagles entrance is the lowest entry to the system and the typical 20-30 m high, 1-3 m wide canyon, which is so distinctive of this cave, can be seen at the entrance. A pool of cold air is always present at the entrance and ice decorations have been noted from time to time. The canyon is partially blocked by a large pile of boulders which necessitate a 9 m pitch to get into the cave. Behind the pitch and leading off to the southwest is a joint controlled rift which is reputed

FIGURE 17. <u>THE EAGLES NEST SYSTEM</u> (Y1,2&3)
Adapted from Pavey (1974)



Surveyed during 1973-74 by
A.Pavey and P.Radcliffe (UNSWSS)
with assistance from members of
UNSWSS, UQSS, SUSS, HCG and YRG.
Survey mainly CRG 6D with some
CRG 5D. Survey computed,adjusted
and drawn by A.Pavey Oct. 1974.
ASF MAP 2Y1.UNS1 /b

to connect with the rest of the system lower down, though this has yet to be demonstrated. The main canyon takes off in a WNW direction for 30 m until the high narrow canyon is blocked by a rockfall. At this point it is necessary to climb and chimney into the roof in order to get around the obstacle. From the top of this climb the route bifurcates; continuing upwards leads to the Eyrie whilst down into the rockpile leads to the lower levels of Western Eagles Nest. The route through the rockpile is a tight corkscrew and leads eventually to a 9 m pitch which can be sneakily climbed on one side. From the bottom a passage leads through massive rockpile until the canyon is again encountered. At this point (next to the 'fuck its cold' inscription) is the dig by Myers and Hockley which linked through to known passage in Eastern Eagles Nest. This low flattener leads into a parallel canyon development past a marvellous draughty dig and on into a superb serpentinous passage before emerging into a much larger canyon. This is then followed down to the junction with Eastern Eagles Nest. The scalloping in this section is excellent and large. This low part of the Western Eagles Nest canyon has a superb red microgour floor, which continues past the junction to Rims End, at the most westerly point in the cave. This section, known as the Golden Streamway, sometimes floods leaving a large standing pool. While the lower portion just described has traditionally been approached through Eastern Eagles Nest, it is distinctively and morphologically part of Western Eagles Nest and it has been proposed that the south-western side of the system be universally known as Western Eagles Nest.

The Eastern Eagles Nest entrance is at the point where the stream sinks into the rockpile, depending on stream flow. Parties usually negotiate this section relatively dry. The stream itself has been reported as being followed for 50 m by an early SUSS party but recent attempts (Pavey 1974) have been stopped by tight rockpile and extensive gravel banks very close to the entrance. After an extensive rockpile has been negotiated for some 50 m the cave becomes massive. In plan it appears to be only 40 m wide but in face the chambers are developed from roof collapse slabs and in the north-south direction it drops off for over 100 m at a steep angle. The Deepest Dig passage leads off from the bottom to the large 'hole' on the northern side of Flatbed Cavern and leads down as a fairly simple meandering stream passage to the terminal chamber which is the site of the dig. This terminal chamber is large and spacious with a flat mud floor. The dig is situated at the northern end and is 3.5 m deep, making the total cave depth from the highest Eyrie entrance, 174 m.

During the middle sixties several paint tracks through the boulder pile in Flatbed Cavern appeared and it is possible to go over, through or below the massive roof collapse slabs and emerge into the lofty cavern beyond. These caverns are so large that little is seen of them. There are quite large and significant soil and mud levels and abandoned stream courses throughout this section and cavers should respect them for what they are. The Railway Tunnel leads down to the Crystal Pools and on out to the junction with Western Eagles Nest. At this junction there are two side passages, one, the northernmost, leads to Rimstone Writeoff, a passage blocked by rimstones reaching the roof, and an obvious original route for Western Eagles Nest. To the south is the Red Crystal Room which has unfortunately been vandalised by mud tracking.

While Western Eagles Nest is a relatively simple morphological feature, Eastern Eagles Nest has a more complex history and appears to have pirated itself a number of times, each time to the north and east of the previous one, until now the stream flows a totally different course to that of the cave.

The Eyrie which is situated right on the lip of the blind valley appears to be mainly a collapse feature. The main hall is relatively low but very extensive when an attempt is made to find the walls. The steep descent to Western Eagles Nest should be approached with caution since, although it can be free climbed, there is a trick to it. For the most part the decoration in the Eyrie is dead and dry but nevertheless quite impressive.

Speleothem development throughout the system is well separated but when it occurs it is typically superb as only Yarrangobilly can produce. Very white flowstone and shawls are admirably out-pointed by micro crystalline 'rivers' in a number of places.

In summary, Eagles Nest is a large and exciting cave system, unique in its size and complexity and worth preserving for both its morphological and speleothem contents. Meteorologically it is also of some interest and the pool of cold air at the western entrance has resulted in a flora markedly different from the rest of the valley. The prospects for further exploration are small but not extinct. Perhaps the greatest hope for the system is that one day someone will break through from or into the resurgence, Hollin Cave (Y46).

Y18 Pot.

Time:- 4-5 hrs.

Walking time - 30 min each way from hill top car park.

Photography - limited

Equipment - entrance pitch 9 m ladder and belay rope, main chamber 15 m ladder, long traces & belay ,vertical squeeze - short ladder or waist loops, 3 m pitch 10 m ladder (+ rope) final pitch 9 m ladder & ropes.

Y18 pot is one of the few caves at Yarrangobilly with principally vertical development. It is approximately 90 metres deep and at Yarrangobilly, is second only in depth to the Eagles Nest system. With 5 pitches, some of which can be free climbed, and patches of wet mud, it is a good sporting cave.

The cave was discovered in 1959 by Paul Rose and Hugh Myers and was visited infrequently until surveyed in 1966. On this trip a tight vertical squeeze, the previous limit of exploration, was penetrated revealing the lower section of the cave.

The cave was once an active stream cave, probably taking water at what was once the surface boundary between the limestone and the overlying basalt capping. However, as the basalt cap eroded, the contact with the limestone moved eastwards, taking with it the stream sink. The water would have drained into the Tombs area then, but is now taken by the Eagles Nest System. In the cave today, many rounded basalt boulders can be seen, but on the surface, all that now remains in the Y18 area are a few isolated patches of residual clay (often containing wombat burrows) with some basalt fragments.

The entrance is in a shallow valley in the Western Tombs and can be hard to find. It is a hole about 1 m across at the base of a limestone block 2 m high. The entrance pitch of over 10 metres (but a 9 m latter is adequate) descends into a high, narrow stream fissure with a steeply sloping floor. The passage soon widens and some breakdown encountered.

At the base of the boulders, a small hole on the left hand side gives access to the rest of the cave. From here, the way is down the most obvious route to a narrow, high roofed chamber. In this area is the best decoration the cave has to offer. Near where the floor flattens out in this chamber, turn left into a parallel passage, and continue down. As the floor flattens out the floor becomes very muddy which makes the top of the ladder pitch rather awkward. The actual pitch is not very high, but absence of a suitable belay point makes it necessary to use a 15 m ladder with a long trace to reach a point back up around the corner.

The ladder drops into the steeply sloping predominantly breakdown floored main chamber. A feature of interest here is the area of phreatic roof pendants near the left hand side. Against the wall of the lower end of the chamber is a small hole which drops 3 m to a tight vertical fissure, the limit of exploration prior to 1966. A short ladder or waist loop is very handy on the way out. The tight snaking tube at the base of the vertical squeese will test all but the most rubbery boned. The short pitch at the end of this squeeze can be free climbed by traversing around to the left. The next 3 m drop is more difficult and a ladder is required. The final 10 m pitch is to a mud blockage, which effectively terminates further exploration.

North Deep Creek Cave (Y 7)

Time - 4 hrs to the duck-unders.

Walking time - 30 min each way from hilltop parking area.

Photography - good in parts.

Equipment - to duck under only - 9 m ladder & rope;
beyond duckunder - scaling pole + 9 m ladder & rope and an additional 15 m ladder & rope. Key to locked gate from rangers.

North Deep Creek Cave has three entrances in the lower end of a short blind valley near the eastern boundary of the limestone. It contains a small perennial stream draining from the valley and its waters are thought to rise at Hollin Cave Y46, near the Natural Bridge in the Yarrangobilly River Gorge.

The Y7 entrance at the end of the valley is the one normally used. This entrance and Y49 30 m further up the valley are former sinking points of the stream, but due to piracy the water now sinks a further 15 m up the valley at Y 48.

North Deep Creek Cave is typical of large active stream caves at Yarrangobilly. The first section is steeply sloping and developed largely in breakdown. At the base of this large breakdown pile, the active streamway is developed in bedrock. The streamway is fairly narrow, but in places a number of small chambers occur. Above this active level are a number of breakdown chambers, some of which are large and well decorated.

From the Y 7 entrance there is a 2 m climb down into the entrance chamber. The gate is across a small hole back underneath this climb. From here the general direction is down through the rockpile to the stream level. The route is fairly obvious on the way in, generally following the line of least resistence. On the wayout though, there are a number of false leads which terminate after short distances.

In the lower parts of the rockpile, the passage is more spacious and the occasional bedrock wall can be seen. In this area the floor levels out and for a short distance is composed largely of mud and gravel. At the end this passage a 4 m climb through a small hole (the climb is easier than it looks) brings one out into a spacious passage with a number of holes in the floor. Down one of these holes, a complete (and undisturbed) kangaroo skeleton can be seen. At the lower end of this passage a 9 m ladder is needed to reach the stream level. The stream fissure can be free climbed at some points, but a ladder is probably quicker and results in less damage and mud tracking.

From here, the route more or less follows the stream, though about 30 m from the ladders, the best route is up, over and along some large boulders, which partly block the passage, and into a dry side section.

In the area of these boulders, one can climb up a considerable distance into some large breakdown chambers which contain some attractive decoration. At the lower end of the dry section drop down through a small hole in the floor and follow the passage back to the stream which is then followed to the duckunders, which are about 200 m from the entrance.

If continuing through the duckunders, a small chamber about 30 m back up the passage is where one changes into wet-suits, swimming costumes etc. The water is extremely cold and the dangers of exposure should not be forgotten. A change of clothes, or a wet-suit is therefore strongly recommended.

The duckunders result from secondary calcite deposits (flowstone) which almost completely block the passage. For many years exploration was limited by the first blockage, and it was only about 5 years ago that a large chunk was chipped out to reveal the continuing passage. Past the second duck, 10 metres further on, the passage opens out and is followed until breakdown is encountered. This is where a change to dry clothes is normally made.

A chamber above this section contains some attractive formation, much of it developed on old stream gravels and mud. In the roof of this chamber is the entrance to the "January Series", a 100 m long extension discovered during the NIBICON field trips. Although only a few metres above the floor, a scaling pole is needed as the vertical mud/gravel wall is not very stable.

Apart from the gear needed for the scaling pole, a further rope and 15 m ladder are needed for the January series. They are used to climb down from the breakdown, mud and gravel floored chambers into a high narrow passage that may contain running water. This passage can be followed for approximately 40 metres until the passage reduces down to a cold, wet crawl, which has not been pushed.

North Deep Creek Cave has many patches of good decorations and it is well worth taking your camera into the section beyond the duckunders and the "January Series", provided it can be adequately protected from the water. Rescue from this cave would be extremely difficult, especially from beyond the duckunders. It is therefore strongly recommended that belays are used on all ladder pitches, and that a change of clothes is carried. Don't forget a belay for the short pitch between stream level and the rockpile. It may give welcome assistance on the way out when people are cold, wet and tired.

Coppermine Cave (Y 12)

Time - 2-3 hrs

Walking time - 30 mins eachway from sump buster.

Photography - good, especially beyond "the squeeze".

Equipment - handline useful. Key from rangers.

From the collapsed entrance to Y12, the cave follows an active stream passage that consists of a narrow, tall (5 - 9 m) canyon. From the 100 m point a higher level may be reached by climbing up through one of the many roof slots that separate the two levels. Except for a dry section ending in a muddy rockpile at the southern extremity of the upper level it lies directly above the stream passage. At about 200 m into the cave the lower level appears to choke off in a massive flowstone structure however by getting a little wet this may be ducked under and access gained to the last 30 m of tunnel-like passage ending in the two sumps. The majority of water flowing in Y12 is believed to enter the known cave at this point.

Access to the rest of the cave is most easily gained by climbing into the upper level prior to the flowstone choke. Past this point the cave is well decorated (although considerably vandalized), dominated by a superb flowstone canyon which drops 4 - 5 m down to what appears to be an upstream extension of the stream. This "stream" undoubtably connects with the main stream upstream of the sumps but it is believed to consist only of local seepage water and rarely flows significantly. It is essentially a standing pool. By keeping to the high levels in the canyon "the squeeze" (which is simply and effectively gated) is reached. On the other side of the squeeze the canyon continues for a further 50 m or so before the upper level disappears and the muddy "stream" passage starts. With the exception of a small section at the end of the cave this is also the end of the decoration and parties are encouraged to go no further without good reason to prevent the tracking of mud back through the clean sections of the cave on the way back.

The rest of the cave consists of muddy, gravel floored passage and chambers considerable amounts of which requires crawling through muddy collapse rockpile. At the far end is a particularly uninviting dig in solid limestone and calcite however strong drafts and rushing water sounds are often experienced at the opening.

Castle Cave, Y31

Time - 2 hrs.

Walking time - 20 min each way.

Photography - some good speleothems, large passage shots.

Equipment - scaling pole + 10 m ladder + rope - needed to see upper level (front part) if party includes anyone over 85 kg or with big shoulders; key to locked entrance gate from rangers.

Description

Castle Cave is one of the old tourist caves of Yarrangobilly and was discovered, and opened, in the early 1890's. Tourist use is still evident in the cave with steps, paths and wire mesh fences to keep stray hands off the goodies.

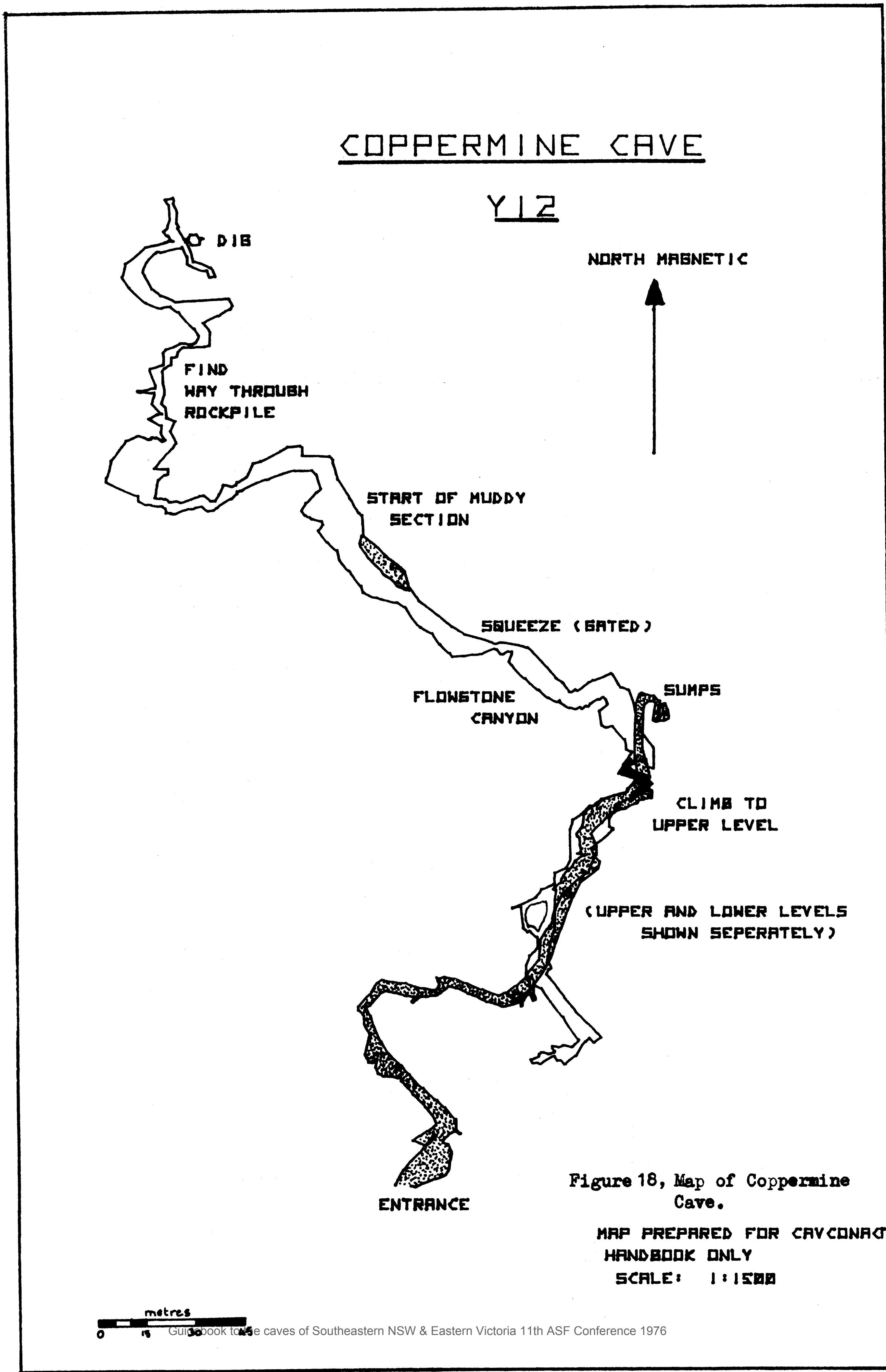


Figure 18, Map of Coppermine Cave.

The cave is developed on two main levels. The upper level is small, 1 to 5 m high, and 1 to 2 m wide, with abundant and reasonably preserved speleothems. The main level is larger, 3 to 8 m high and 2 to 5 m wide. Speleothems are concentrated in sections and are more massive than anything in the upper level. The best speleothems in the cave are found in the Great Dome - King Solomon's Temple area.

The Castle Walk leads directly to the main entrance. The entrance to the upper level is about 13 m above and a little north of the main entrance. After passing the typical (for Yarrangobilly) entrance that is nearly blocked (and once was) by columns the passage meanders to the Dome Chamber that is 40 m from the entrance. This room, with a roof height of 17.4 m, has the second highest ceiling in the cave. A ladder climb, through an aven near the entrance end of the room, leads to the upper level.

Beyond the Dome Chamber the passage continues for 42 m to the Crystalline Cascade where a narrow passage, cut into flowstone, leads through speleothems to the start of the Great Dome chamber.

From the point where the passage opens out to the base of the Great Dome slope is 24 m. From this point Please Stay on the Tourist Track! The flowstone covered breakdown rises 8 m to the semi-artificial formation known as the Trig. Station. The roof of the Great Dome rises another 18 m above the Trig. Station.

From the Trig. Station the right path leads up to King Solomon's Temple, another massive flowstone formation, and the back part of the upper level. Under the Temple ledge, near the path into the upper level, a single straw hanging into a pool has golf-ball size calcite growth on its end and is well worth the photo.

The passage off the top of K.S.T. is the back end of the upper level passage. Speleothems of note in this section are the semi-transparent helictites known as the Crystal City, located just beyond the end of the tourist track.

The left path from the Trig. Station leads down to the Coral Grotto and Queens Boudoir sections, with their numerous straws, and to the passages that extend beyond the tourist section.

Beyond the end of the tourist track a hole leads down a short slope to an elongate room. Avens in the roof of this room lead to a crawlway that opens into a short continuation of the main level. A hole in the floor of the room leads to a lower level that is terminated by fill after 20 m.

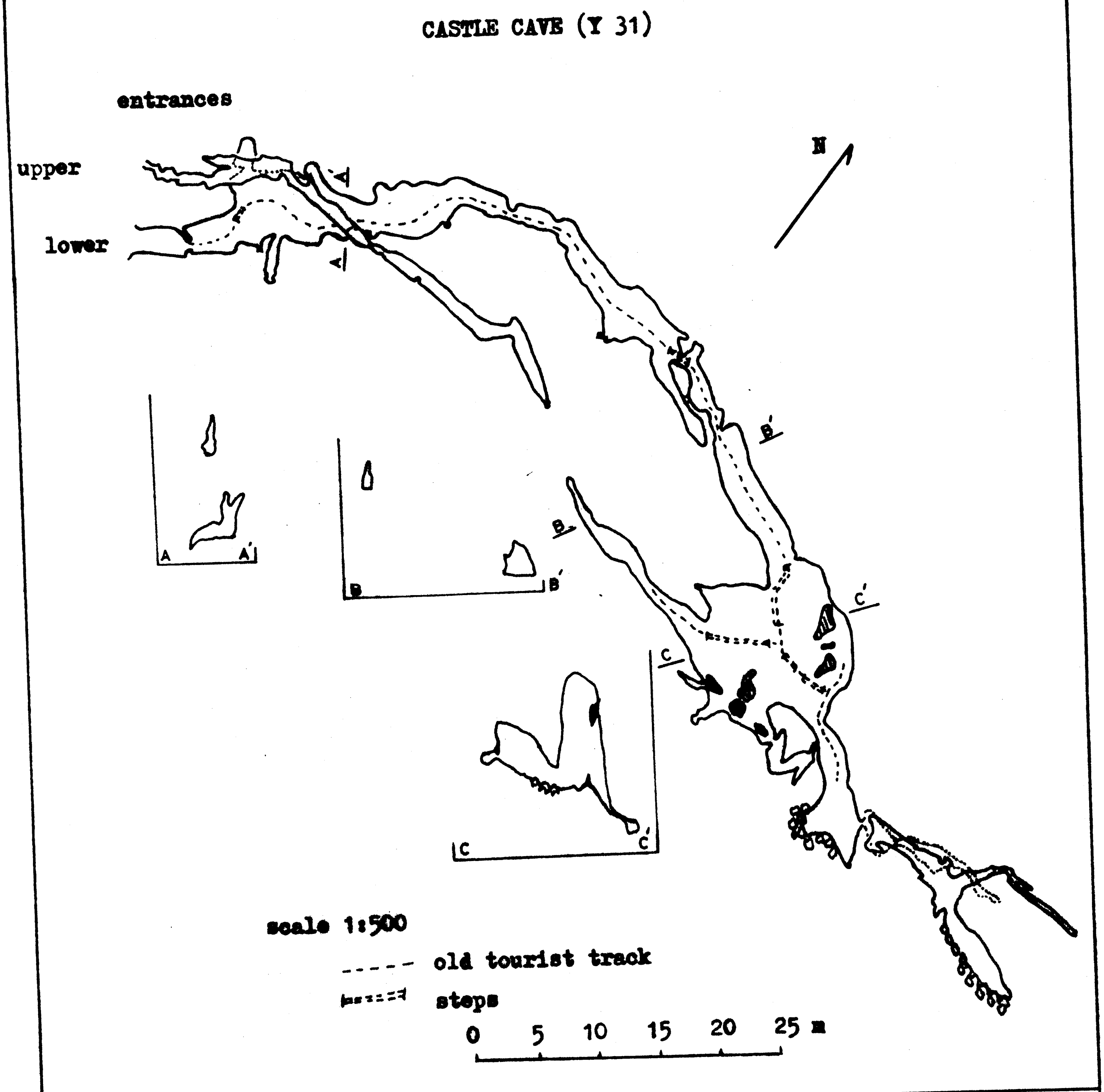


Fig. 19. Plan of Castle Cave. Simplified from the preliminary map prepared by YRG/CSS, 1973.

UPPER SHOALHAVEN KARST REGION

The Upper Shoalhaven Karst Region consists of five distinct but related cave areas. These are, from north to south, Cleatmore, Marble Arch, Big Hole, Wyanbene and Bendethra Cave Areas. Except for Big Hole, all of these areas are developed in limestone bodies of Late Silurian age. Big Hole probably represents the collapse of Devonian sandstone into a cavity developed in underlying limestone.

Cleatmore, Marble Arch and Bendethra drain into the Deua River and Wyanbene drains into the Shoalhaven River. Bendethra is the lowest of the limestone areas, at an elevation of 440 to 600 m. The lowest limestone at Marble Arch is at 620 m. Cleatmore has an elevation of around 700 m and Wyanbene from about 900 to 1000 m.

Access to Cleatmore, Marble Arch, and Big Hole makes use of the Bettowynd Fire Trail. Wyanbene is reached by use of a rough track adjacent to Wyanbene Caves Creek. Bendethra can be approached by a walking track that crosses the Minuma Range (1000m) and drops the 400m to the elevation of the caves or by driving from Moruya along fire trails.

Caves at Cleatmore are not included because most are small and insignificant. The largest cave contains a bat colony and should not be disturbed.

Accommodation and Provisions

Camping sites are indicated on the regional map. The sites are near each of the cave areas. The only reliable water is the Shoalhaven River. Drinking water should be carried. Petrol and some supplies can be obtained at Captains Flat and Majors Creek, but most provisions should be obtained in Canberra or Braidwood.

BIG HOLE CAVE AREA

Big Hole is a further feature of interest in the Upper Shoalhaven Karst Region. It is a hole 25 x 35 metres across and 110 metres deep on a hillside on the eastern side of the Shoalhaven River. The access track is the same as that for Marble Arch. About 3 km in from the river, to the left of the track is a flat grassy clearing. A side track branches off here, heads down the track for about 100 metres, turns left and heads up the hill to Big Hole.

The clearing is often wet and boggy and as vehicles have caused erosion on the hillside, please leave vehicles on the main track and walk to the Hole. It is only a few minutes walk.

Big Hole

Time - how fast can you climb? allow at least half a day for the round trip by the party.   Walking time 5-10 minutes.

Photography - It is an impressive, big hole, from above or below.

Equipment - Pitch is about 90 metres, and nearest belay point is back about 15 m from the edge of the hole.

Big Hole is developed in Devonian siltstone, sandstone and conglomerate. These gently dipping sediments outcrop over a wide area in the Upper Shoalhaven valley and overlie Silurian sandstone, limestone, shales and volcanics. It is thought that the hole formed by collapse of the Devonian sediments into a large cavity developed in an underlying limestone lens.

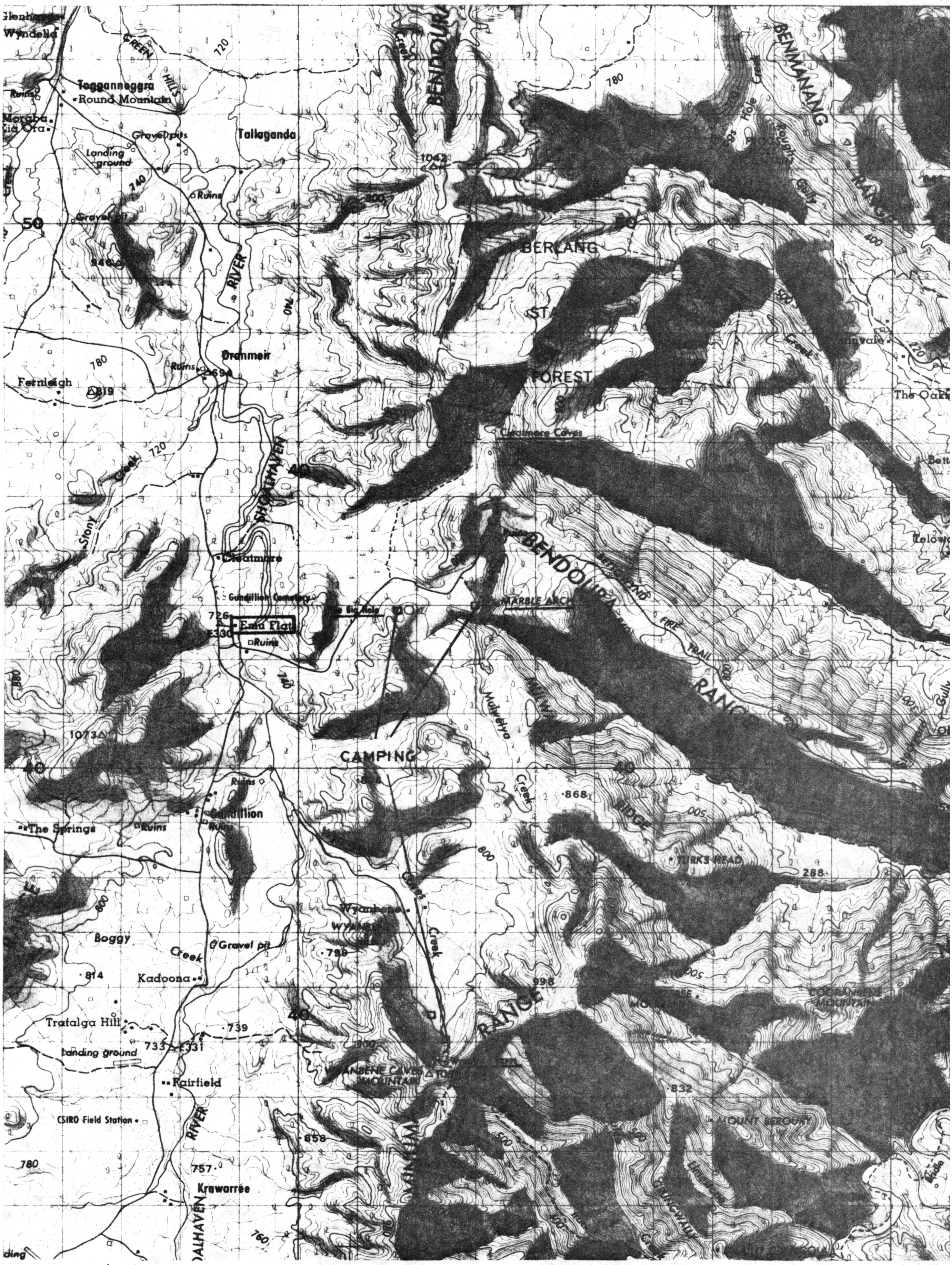


Fig. 20. Location map of part of the Upper Sholahaven Karst Region showing the Big Hole, Marble Arch, Cleatmore and Wyanbene Cave Areas. Araluen 1:100,000 topographic map.

Collapse has been facilitated by two parallel faults which intersect the hole. One of these can be seen as the large flat rock face on the south-western side and the truncated bedding on the northern side. The other fault on the eastern side is not as obvious but has made the lower side of the hole rather unstable. It is because of the unstable nature of the eastern wall that the hole is usually climbed from the northern or western sides; despite the 20-30 m longer pitch.

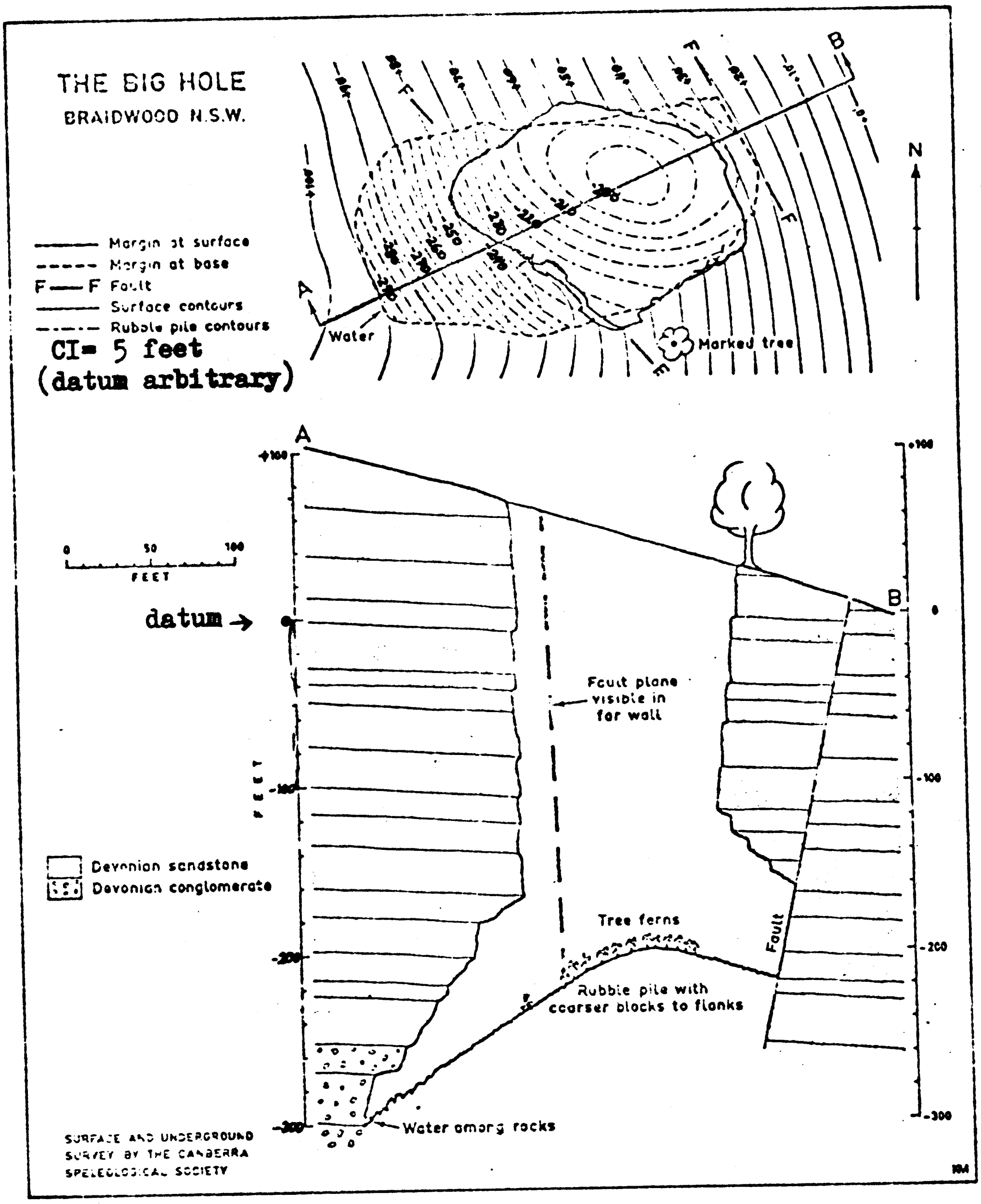


Fig. 21. Plan and section of Big Hole. Modified from Jennings, 1967.

Although the floor looks reasonably flat from above, it is in fact, a conical boulder pile which continues down to the lowest point under the overhanging western wall. Until recently, there was a thick covering of the ferns on top of this pile, but much of this was obliterated by a rockfall from the top of the eastern wall.

Depending on positioning of the ladder (or rope) the base of the climb is either on the side or near the top of the boulder pile. In the "alcove" on the eastern side the visitors book is housed. The boulder pile on the other side drops down much further and may have a pool at its base. This pool is at about the same level as the Shoalhaven River.

In short, a long climb but well worth the effort.

WYANBENE CAVE AREA

The Wyanbene limestone crops out on the western side of the Minuma Range, between the Shoalhaven and Duea Rivers. Several caves are known in the area, though apart from Wyanbene Cave and the 35 m deep Ridge Mine Pot, they are relatively small. Only Wyanbene Cave is considered here.

The track in from the road is followed across the Shoalhaven River and is about 8 km to its end. The track ends only a few metres from the cave entrance, but to avoid congestion, it is preferable to park a couple of hundred metres back down the track in the flat, grassy clearing. This is the normal campsite if staying overnight. There is no water here, so please remember to fill your containers at the Shoalhaven.

Wyanbene Cave (Wy 1, 2)

Time: 5+ hours (more if going to lake) — Walking time up to 5 min.

Photography: good in parts

Gear: Blowhole - 9m ladder & belay rope
for trip to lake following additional gear needed:
- rope or ladder for Diarrhoea Pit
- rope or short ladder for Chamber Pot
- 9m ladder for Anderson's Wall

Wyanbene cave is amongst the longest in New South Wales with over 1830 m of passage. It contains an active stream passage with some large predominantly breakdown floored chambers and a number of high avens. Parts of the Cave have been well known at least since the latter part of last century. The outer sections were used as a tourist cave in the late 1890's and early 1900's, though it was not until the 1960's that sections beyond Sump Two were discovered.

The cave has three entrances. The small Wy 1 entrance is at the base of the limestone outcrop near the end of the vehicle track. In wet weather the cave stream rises here, though it normally disappears into its bed a few metres inside. The second vertical entrance drops into the fissure just inside the first, and avoids the tight entrance squeeze. The entrance normally used however, is further up the hill. Just follow the obvious track. The entrance gate and ladder and other ladders in Mud Chambers date from the old tourist cave days.

Apart from a short crawl through the stream at the base of the entrance climb, the outer section is a mostly spacious stream passage with some massive decoration. The stream is followed to near Sump One, where one climbs up between some large columns to a flat, muddy flowstone floor.

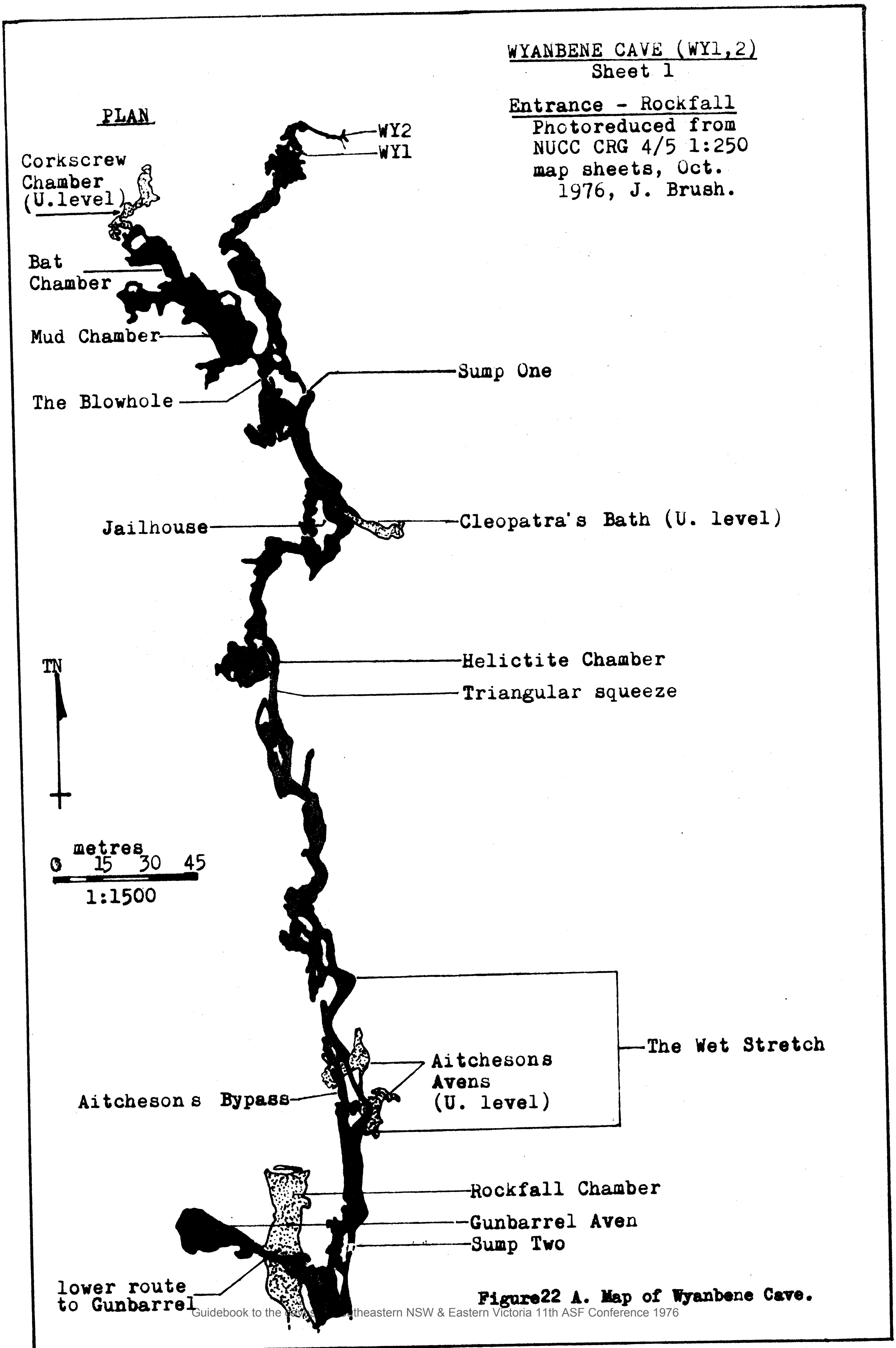


Figure22 A. Map of Wyanbene Cave.

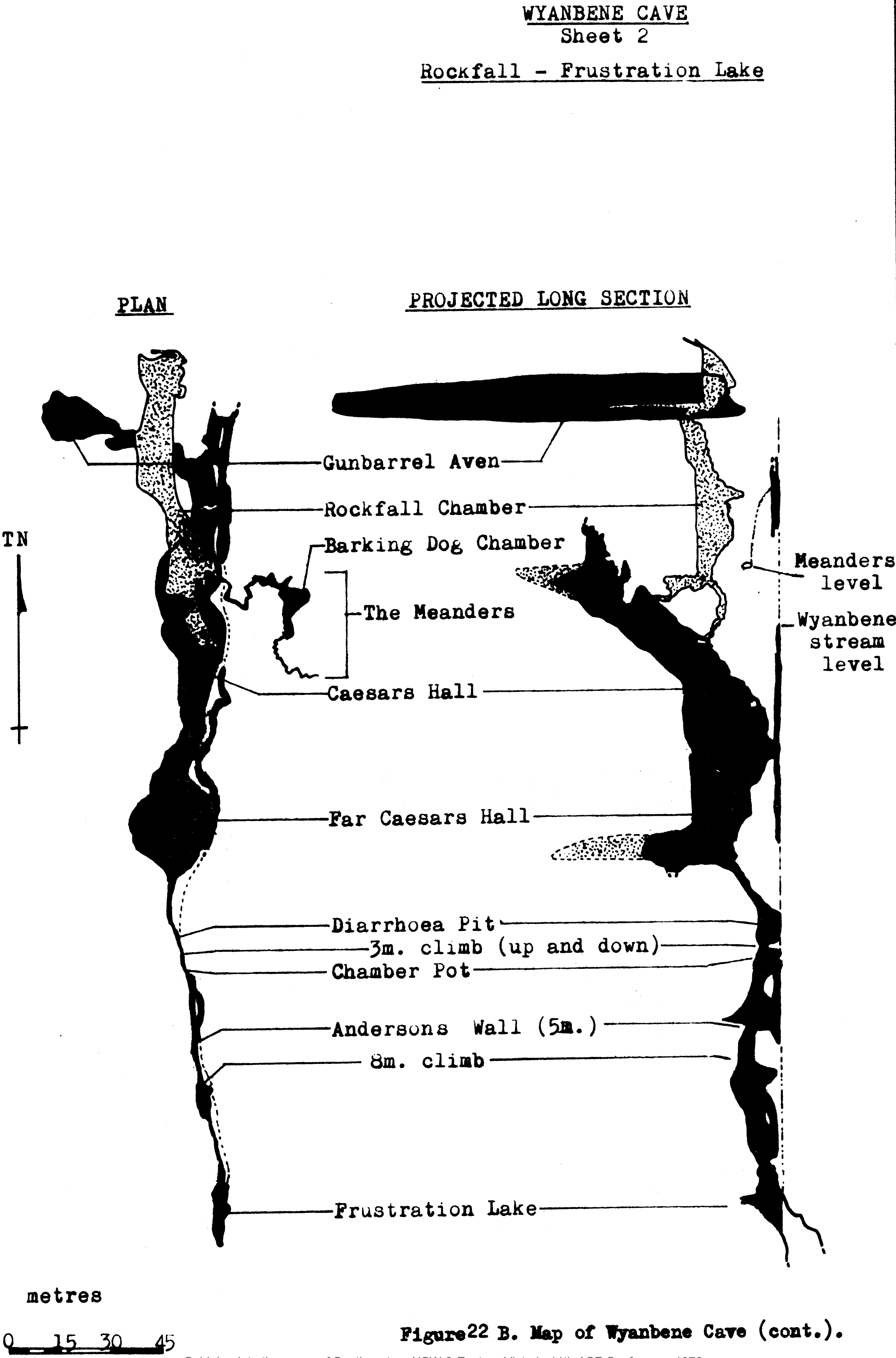


Figure 22 B. Map of Wyanbene Cave (cont.).

A small hole on the western side leads to Mud Chamber, Bat Chamber (the old tourist section) and Corkscrew Chamber. This section is well decorated in parts, though heavy traffic in recent years has taken its toll. Corkscrew Chamber is so named because of the twisting vertical squeeze used to climb up into it.

To continue into the rest of the cave from the flat flowstone floor, climb the flowstone cascade and through The Blowhole at the top. The short ladder pitch (6 m) on the other side brings you back to stream level beyond Sump One. The stream passage is now followed through to the wet stretch and Sump Two. A number of excursions up into dry passages on the western side can be made to keep you drier that extra bit longer.

Other detours into upper levels can be made for aesthetic or photographic reasons. Both Cleopatra's Bath and Helictite Chamber have areas of good decoration, including some excellent, large helictites. Cleopatra's Bath is on the eastern side near the Jailhouse. There are two routes, one either side of Jailhouse Constriction. Helictite Chamber is on the western side of the stream passage. There are two entrances, both through squeezes a metre or two above stream level.

The wet stretch is a very low wet crawl. The wettest section can be avoided by taking Aitcheson's Bypass. The entrance to the Bypass is a small vertical hole near where you can avoid the stream for a short distance. At the inner end of the Bypass the low, wide Aitcheson's Squeeze brings you back to stream level. The route to Aitcheson's Avens (Peter Aitcheson discovered this section of the cave would you believe) is up over the boulders in the central part of the bypass. There are three avens in this area, two of which reach up over 70 metres. The base of the third is well above that of the others and is reached by chimneying up fissures. It is rather difficult to get to, has not been mapped, and to our knowledge has not been entered since its discovery in 1970, so there may be prospects for new discoveries.

Sump Two was the limit of exploration until 1966 when a cunning little bob down under a rock near stream level revealed a small passage continuing up the other side. The trick is to put your feet in the small rounded pool, bob down and go up the other side of the rock. A 4 m steep slippery climb is encountered soon after.

At the top of this climb, the route to Gunbarrel Aven is up to the right (west) and down behind the large boulder at the top of the chamber. The route followed is down between boulders, along a muddy floored passage with some sharp crystal growths on the walls and up into Gunbarrel at the far end. The western side of the Gunbarrel is roughly circular, about 12 metres in diameter with fluted vertical walls which reach up over 105 metres. Numerous expeditions have spot lighted, estimated, measured and photographed (even from balloons sent aloft) the roof of this aven. From the quantity of volcanic rock fragments on the floor, it seems likely that the top of the aven has run out of limestone.

Back in the main passage the route to Rockfall Chamber is obvious. The interesting, narrow winding meander section is off the bottom of this chamber; just follow the rimstone pools up. This section often contains a small stream, several metres above the main Wyanbene stream. It enters from the top of a narrow fissure at the inner end and its source is not known.

There are two routes to Caesar's Hall. One is up and one down, both from the top of Rockfall Chamber. The lower route is the one usually taken. Caesar's Hall is a very long, narrow chamber with a steeply sloping mud and rock floor. Some patches of good crystal development can be found along the walls and amongst the large boulders. Far Caesar's Hall is wider and flatter than the rest and the predominantly mud floor is usually slippery.

If carrying on to the Frustration Lake, Diarrhoea Pit is at the base of the long sloping tube from the end of Far Caesar's. A rope or ladder is handy here on the way out. Diarrhoea Pit is at stream level and the name is most appropriate. The short up and down climb to Chamber Pot needs at least a waist loop or two, though using a short ladder is much easier.

The last real obstacle encountered is Anderson's Wall. Usual practice here is for someone to chimney up the fissure and fix a ladder for the rest of the party. This ladder can then be used on the other side to get back down to stream level. In this final section of the cave there is very little decoration apart from some excellent aragonite flowers near the lake.

The lake is the main source of the Wyanbene stream. The source of the lake however, is not known. The lake has been plumbed and dived and the passage found to continue underwater for at least 15 m beyond the end. The passage dimensions do not diminish, but exploration was terminated when heavy silting reduced visibility to zero.

MARBLE ARCH CAVE AREA

The Marble Arch Cave Area is located on Reedy Creek just upstream from its junction with Moodong Creek. A narrow belt of marble, thought to be of Silurian age, extends for a distance of 1 km along the valley and Reedy Creek has entrenched itself into the marble. Just downstream from the lower entrance of Marble Arch Cave the creek flows through a canyon that is 2-3 m wide and up to 25 m high. The area contains several caves but only two, Marble Arch and Moodong, are considered to be of significant size. A well beaten track leads down from the parking area to the upstream entrances of Marble Arch.

Marble Arch Cave (MA 1, 2, 10, 11)

Time: 1 hr — Walking time - 10 min down, 20 min up

Photography - good passage shots, interesting breccia in wall.

Equipment - none

Reference - Nicoll et al., 1975, Proc. 10th Biennial Conference ASF, p. 1-5.

Marble Arch Cave is the largest of the caves in the area. The development of the cave has been discussed by Nicoll et al (1975) by interpreting the complex of different passage cross-sections and levels. The cave generally lacks speleothem development.

The main cave is about 50 m long and the Lake Chamber passage adds an additional 35 m of passage. The elevation difference between highest and lowest points in the cave is 20 m. At the downstream entrance (MA 2) the passage is 10 m high and 6 m wide, not including the undercut ledge that adds another 4 m to the width. Just inside the

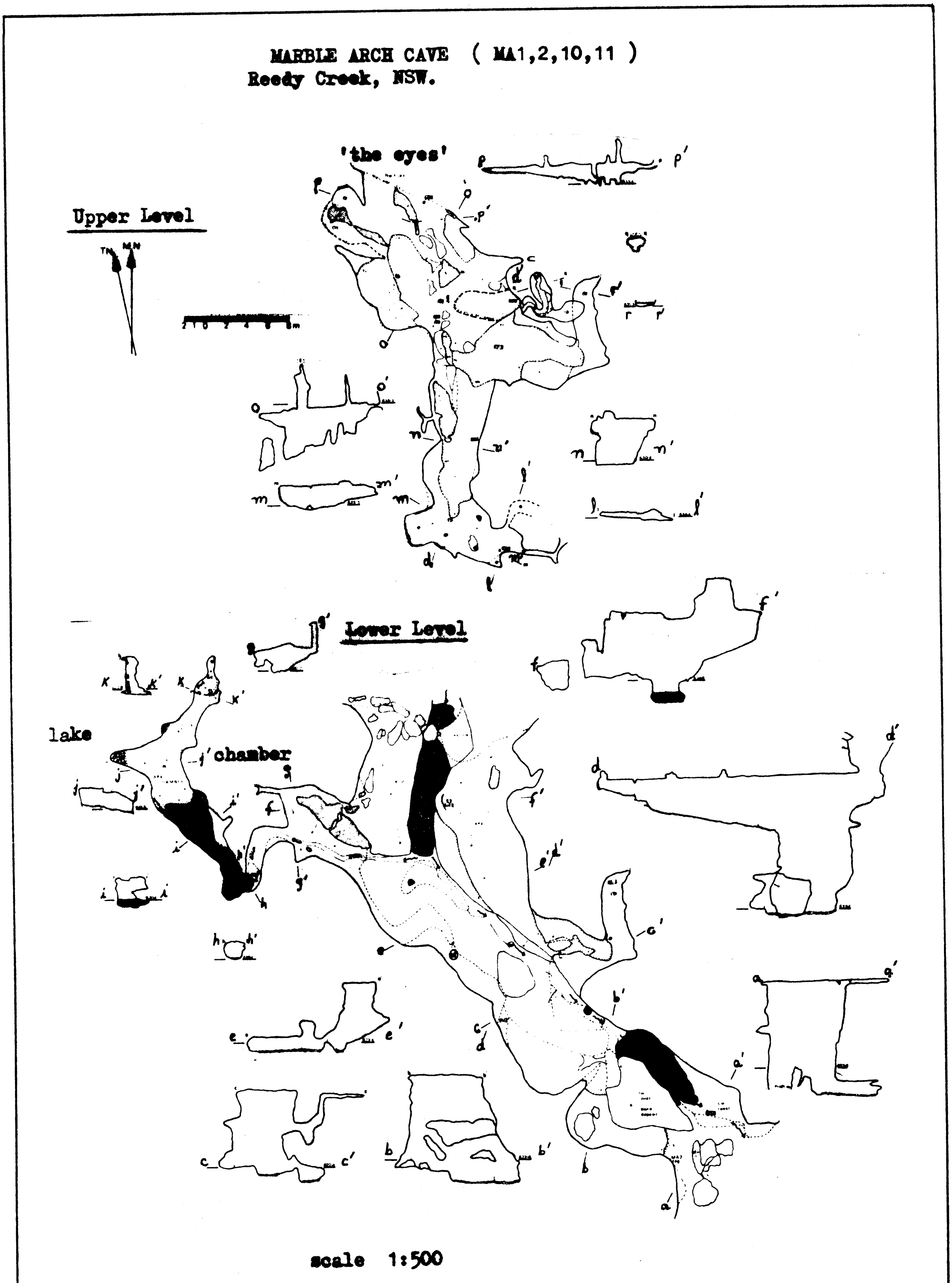


Figure 23. Map of Marble Arch Cave. Map by CSS, 1974. Drawn by A. Spate.

upstream entrance (MA 1) the lower level is 16 m wide and 12 m high. The upstream entrance of the upper level - the Eyes entrance (MA 10) is 9 m wide and 1.5 m high. The Daylight Hole entrance is 6 m long and 2.5 m wide.

The cave may be roughly divided into two major inter-connected levels, an upper dry level and the lower level that contains the active cave stream. The upper level has two entrances at the Eyes level (MA 10) and the upper Daylight hole entrance (MA 11). A number of ceiling canyons extend up to 4 m above the flat roof of the upper level. The downstream end of the upper level ends in clay and gravel fill.

The lower level contains most of the flow of Reedy Creek. Just inside the upstream entrance the flow of the creek is split, depending on water levels, with part of the flow going to the Lake Chamber and part toward the downstream entrance. The main passage at stream level is 8 to 12 m wide with roof heights on the order of 10 m.

The Lake Chamber has streams entering from the main passage and from a small waterfall that probably comes directly from Reedy Creek slightly upstream of the cave entrance. The streams sink in a low passage near the entrance to the lake chamber. This water re-appears as the stream in Moodong Cave.

Moodong Cave (MA 4-6)

Time - 1 hr

Walking time - 5 min downstream from Marble Arch

Photography - passage shots

Equipment - hand line for entrance

Moodong Cave is located in the western wall of the Marble Arch gorge, about 70 m south of the downstream entrance of Marble Arch Cave. The cave has about 140 m of passage and 4 entrances (3 tagged). The stream exit (MA 4) is the southern-most of these entrances but cannot be entered because of the water flow rate. The MA 5 entrance is about 15 m north of the stream exit and located about 3 m above the bed of Reedy Creek.

The cave consists of 4 different types of passage. The active stream is flowing in a narrow canyon passage that is usually less than 1 m wide and 2.5 to 3 m deep. The second passage type is the low crawlway that connects the MA 5 and MA 6 entrances and include the untagged "entrance". This crawl passage is 2.5 to 4 m wide and .5 to 1 m high. The third passage is an upper level canyon passage that is up to 5 m high and 3 m wide. This upper level runs roughly perpendicular to the Marble Arch gorge from the MA 6 entrance. The last passage type is found in the inner-most part of the cave. The passage cross-section of this portion of the cave is quite variable but is up to 6 m wide and 1 to 2 m high. The cave stream rises in this passage and then flows into the narrow stream canyon.

The cave is entered by way of the MA 5 entrance where a handline may be useful. The MA 6 and the untagged entrance are located 6 to 8 m above the bottom of the gorge. The cave contains few speleothems but is otherwise very interesting.

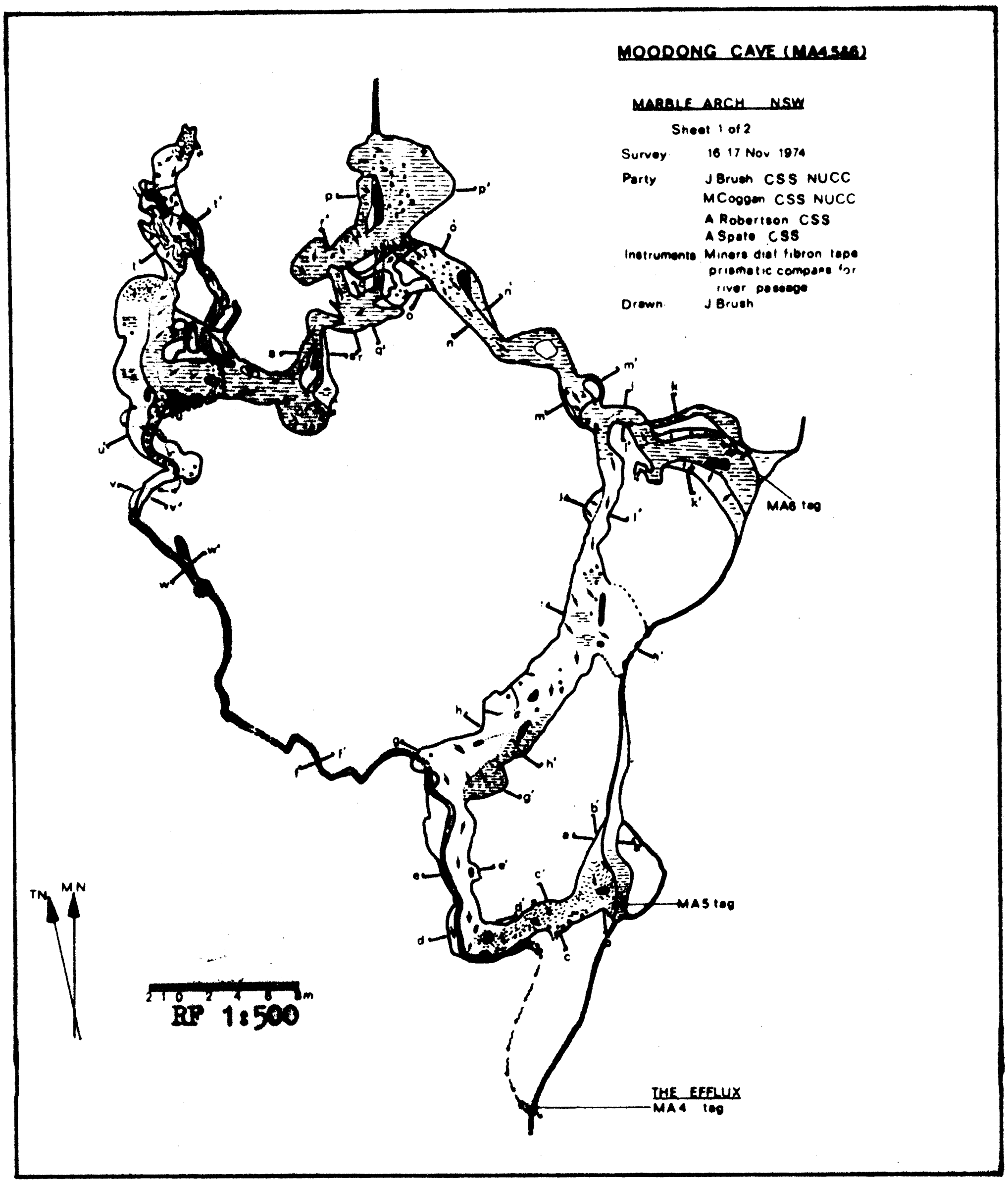


Figure 24. Map of Moodong Cave.

BENDETHRA CAVE AREA

Minuma Range is a single, well defined, ridge with many spurs running down into the valley of the Deua River. The caves are on Con Creek, near the base of one of these spurs. The vegetation consists of fairly dense eucalypt, with light to medium undergrowth. Where the limestone outcrops, however, there is a sharp change to sapling size wattle, with the occasional Kurrajong. The limestone occurs in patches down the east side of the Minuma Range. Most of the caves require some bush bashing to reach the entrances, the wattle saplings making walking rather difficult. There are numerous entrances in the area, though most of the caves are small and not extensive. In general they are vertical, although the Main Cave (BD 1) is horizontal.

There is a good camping spot at Flagpole Flat with plenty of water (Con Creek). There are no other facilities. The nearest provisions would be from Braidwood.

Main Cave (BD 1)

Time - 2 hrs

Walking time - 15 min each way, from camp site.

Photography - passage shots

Equipment - none.

The entrance to this cave is located some 300-400 metres up the range from the camping area. The cave is generally horizontal, has a large cross-section and runs directly back into the hill for some 200 metres. No equipment is required for this cave and it is generally dry, though some mud may be encountered. The formation is on the same scale as the cave - quite large - also unfortunately, quite vandalised.

Windlass Pit (BD 3)

Time - 2 hrs

Walking time - 15 min each way

Photography - passage & action shots

Equipment - 65m ladder and appropriate rope

Windlass Pit is a 61 m deep cave with a series of pitches. An entrance pitch of 38 m, divided by small ledges into drops of 15, 16 and 6 m respectively, followed by two successive pitches of 3.5 m each lead to a small room. From this room a hole in the wall leads to a 4 m chimney and on through a narrow fissure to a final drop of 4 m to a small chamber with a silt covered floor. Narrow fissures lead down from this level but are too small to be entered.

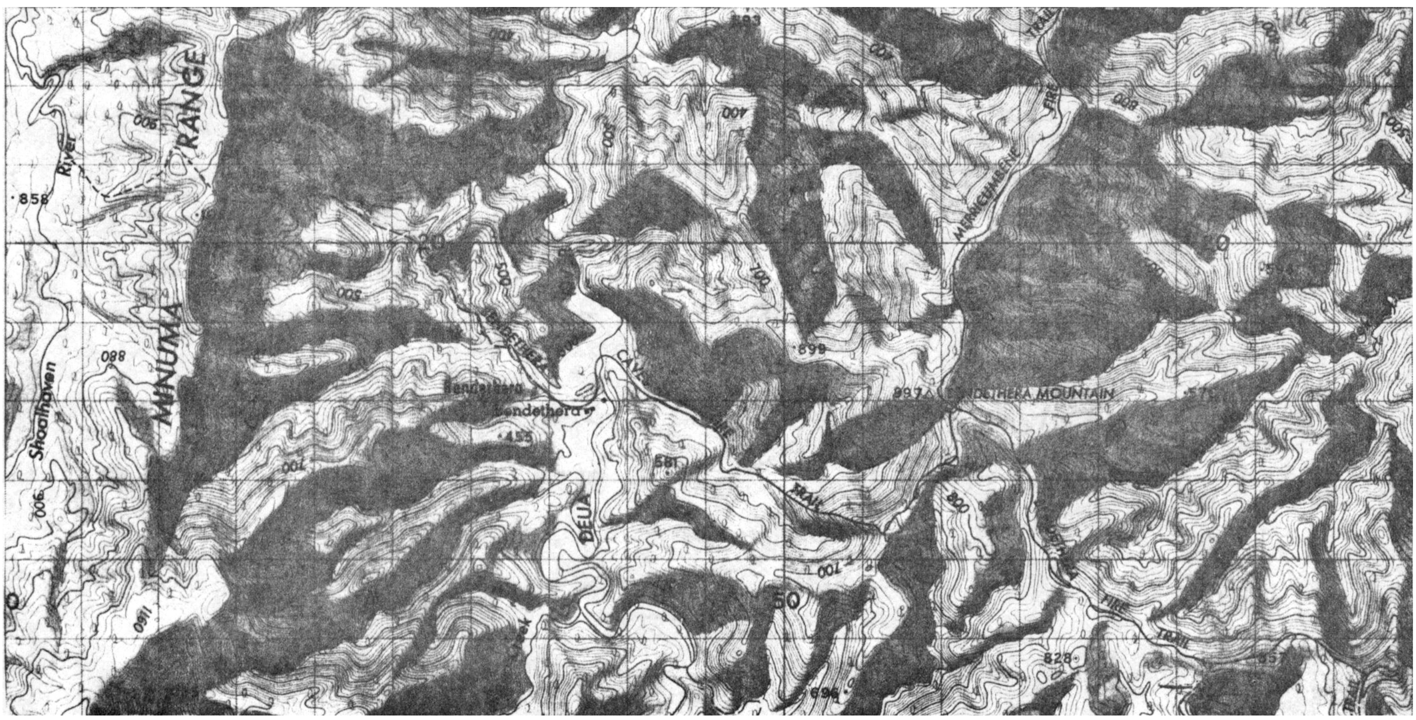


Fig. 25. Location map of the Bendethera Cave Area. Araluen 1:100,000 topographic map.

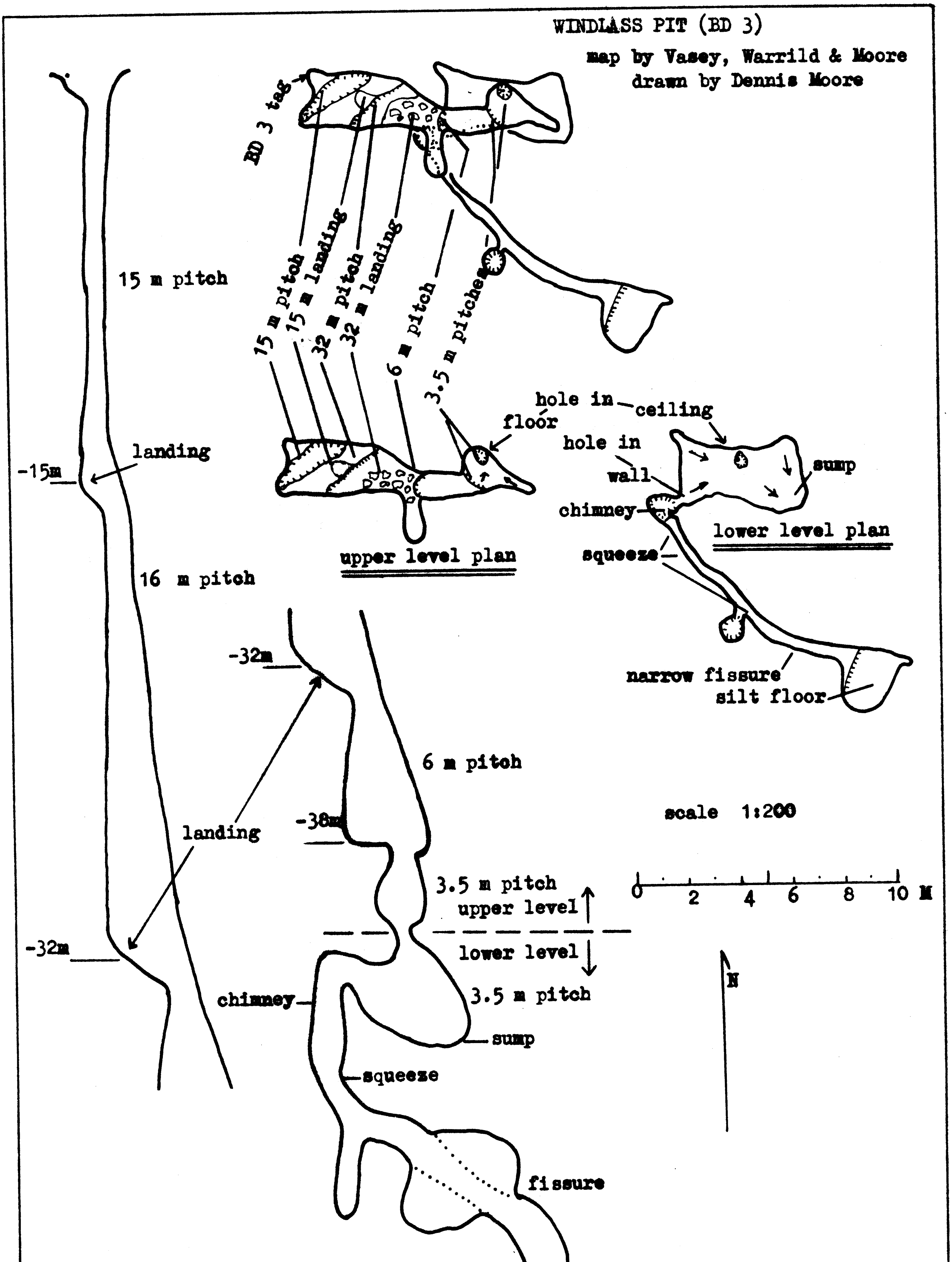


Figure 26, Plan and section of Windlass Pit (BD 3). Modified from Moore, 1975.

LOWER SHOALHAVEN KARST REGION

The Lower Shoalhaven Karst Region is located adjacent to the lower reaches of the Shoalhaven River. The major area Bungonia about 30 km south-east of Goulburn and 15 km south of Marulan on the Southern Tablelands of New South Wales.

Two of the cave areas in the region, Bungonia and Jerrara, are separated by Bungonia Creek which flows eastwards to the Shoalhaven. Both areas are on plateaux with an elevation of about 600 m which fall away steeply to Bungonia Creek and the Shoalhaven River over 300 metres below. Both areas are on steeply dipping, recrystallised Silurian Limestone. There are two limestone units which are separated by shale and siltstone.

Jerrara is on the north side of Bungonia Creek and as the only known cave was removed by quarrying operations some years ago, it will not be discussed further in this guidebook.

BUNGONIA CAVE AREA

Bungonia is reached by following the road in from Bungonia village for about 10 km. The area is essentially a limestone plateau overlooking the magnificent Bungonia Gorge and the "picturesque" Marulan limestone quarries.

The caving area is freely accessible to all and no permits are required. Over 120 cave entrances have been tagged, and although most of the caves are small, there are a number of large ones. These are mostly vertical and require lengths of ladder or S.R.T. gear. There are only two caves with restricted access at the present time. Drum Cave (B13) is a bat maternity cave from November to March and consequently people are strongly requested to leave the bats undisturbed by not entering the cave. Odyssey Cave (B24) is the other with restricted access. Dr Julia James has a series of experiments in progress here and the cave is gated.

A special warning is given here on the presence of foul air at Bungonia: high concentrations of CO_2 accompanied by a low concentration of O_2. The combination is at best unpleasant and debilitating, and at its worst, fatal. It is generally present in the lower reaches of the caves, usually in concentrations of between 1 and 2%. This is sufficient to put out matches, cause headaches and laboured breathing. At other times the concentration can rise to 6%. In some instances it will be found at higher levels in the cave, sometimes just inside the entrance. A box of matches should always be carried while caving at Bungonia, to check for the presence of CO_2. If the match will not light do not panic, but move to a more healthy area of the cave.

Accommodation and Provisions

Bungonia is a primitive flora and fauna reserve. There is no accommodation, no facilities, no electricity, no water and no fees, i.e. you get exactly what you pay for. Water is available in nearby Bungonia Creek, but it is best to bring your own. The nearest petrol is at Goulburn or Marulan, on the highway. The same goes for food and provisions.

Details of a good cross section of caves to "do" at Bungonia are given below. Information on other caves can be

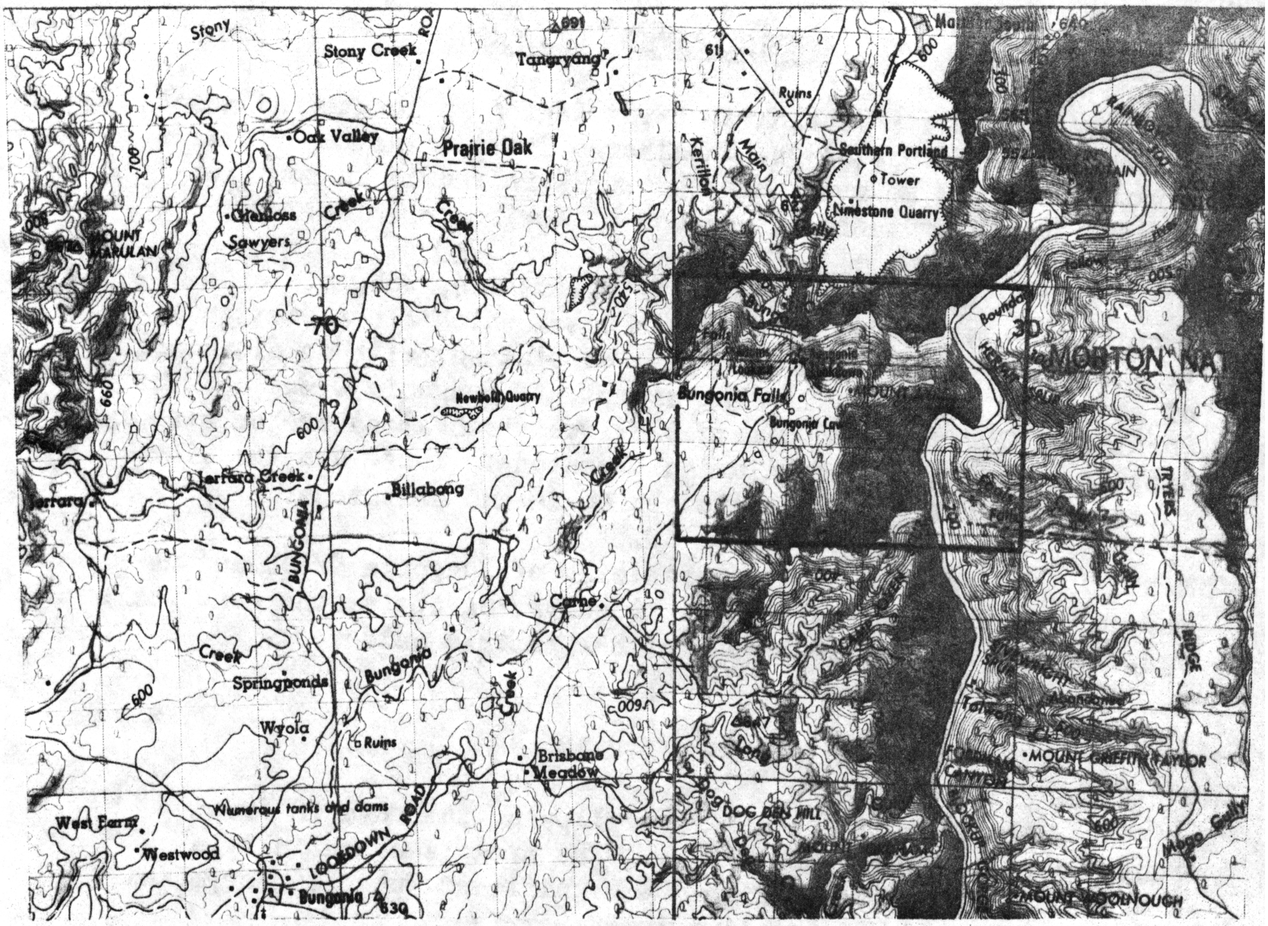


Figure 27 . Location map of the Bungonia Cave Area. The area outlined is enlarged in the following figure. Moss Vale and Goulburn 1:100,000 topographic maps.

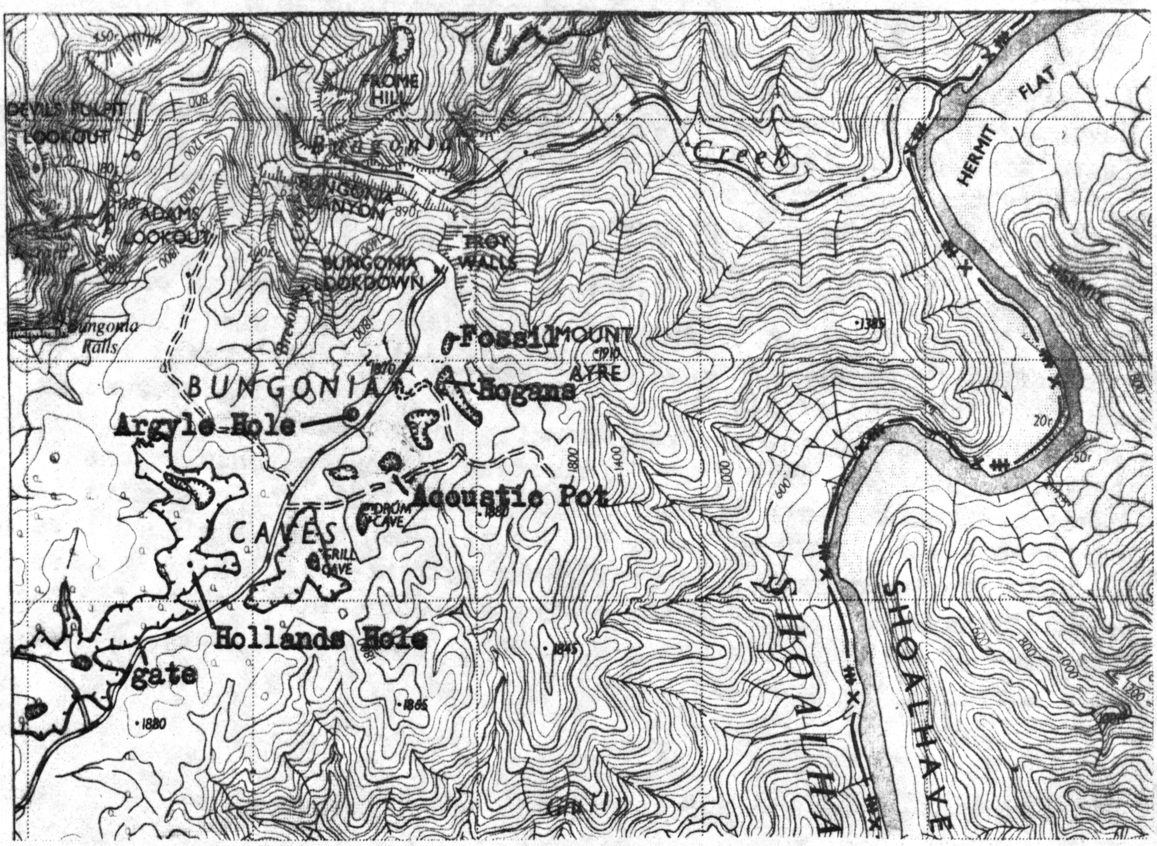


Figure 28 . Location of selected caves in the Bungonia Cave Area. Caoura 2 inches to 1 mile topographic map.

found in Bungonia Caves, Sydney Speleological Society Occasional Paper No. 4, published in 1972.

Fossil Cave (B4) Hogan's Hole (B5) B4-5 Extension

Time: B4/5 2-4 hours plus an additional 5 for the extension. Walking time: park near entrance.

1st pitch - 12 m ladder, 1 trace, 30 m rope
2nd pitch - 6 m ladder, 1 trace, 15 m rope
3rd pitch - 6 m handline
4th pitch - 9 m ladder, 2 traces, 30 m rope.

WARNING - CO_2 can be present anywhere from the 1st pitch onwards. If it is encountered, do not carry on.

Photography: Limited to passage shots.

Reference : Bungonia Caves

Enter via Hogan's Hole (B5) which is in a large doline and at the base of a 20 m cliff. The short entrance climb leads down to a boulder floored chamber and the first pitch. Belay to boulder. 2nd pitch at foot of first pitch. Belay to jug hold on wall to the left.

A tight squeeze leads to the entrance to "The Extension". Initial section sometimes requires digging. 300 m crawl to largest chamber. Very tight in sections.

3rd pitch through boulders on far side of chamber. Large passage continues to "Upside down row-boat tunnel". The main passage develops a flow canyon. After a while the passage becomes low and difficult until you arrive at the "Lavatory Pan squeeze". A further squeeze leads to the top of the 4th pitch. A short low passage brings one to the "Serpent". A squeeze in the floor at the end of the Serpent comes out over a 3 m drop - take care. The passage continues to an aven. The way on down is back under itself. The next section is very tight and serpentineous, and is named "Baby Snake", and is not recommended for large people. Following the tight sections is a wet swimming section 25 m long, then a walking passage to St Patrick's Lake, which is the limit of exploration.

Acoustic Pot (B22)

Time: 2-3 hours Walking Time: park near entrance.

Gear: 36 m ladder and 75 m rope.

Photography: A spectacular rounded shaft.

Reference: Bungonia Caves.

The cave entrance is situated in a doline. It was dug out

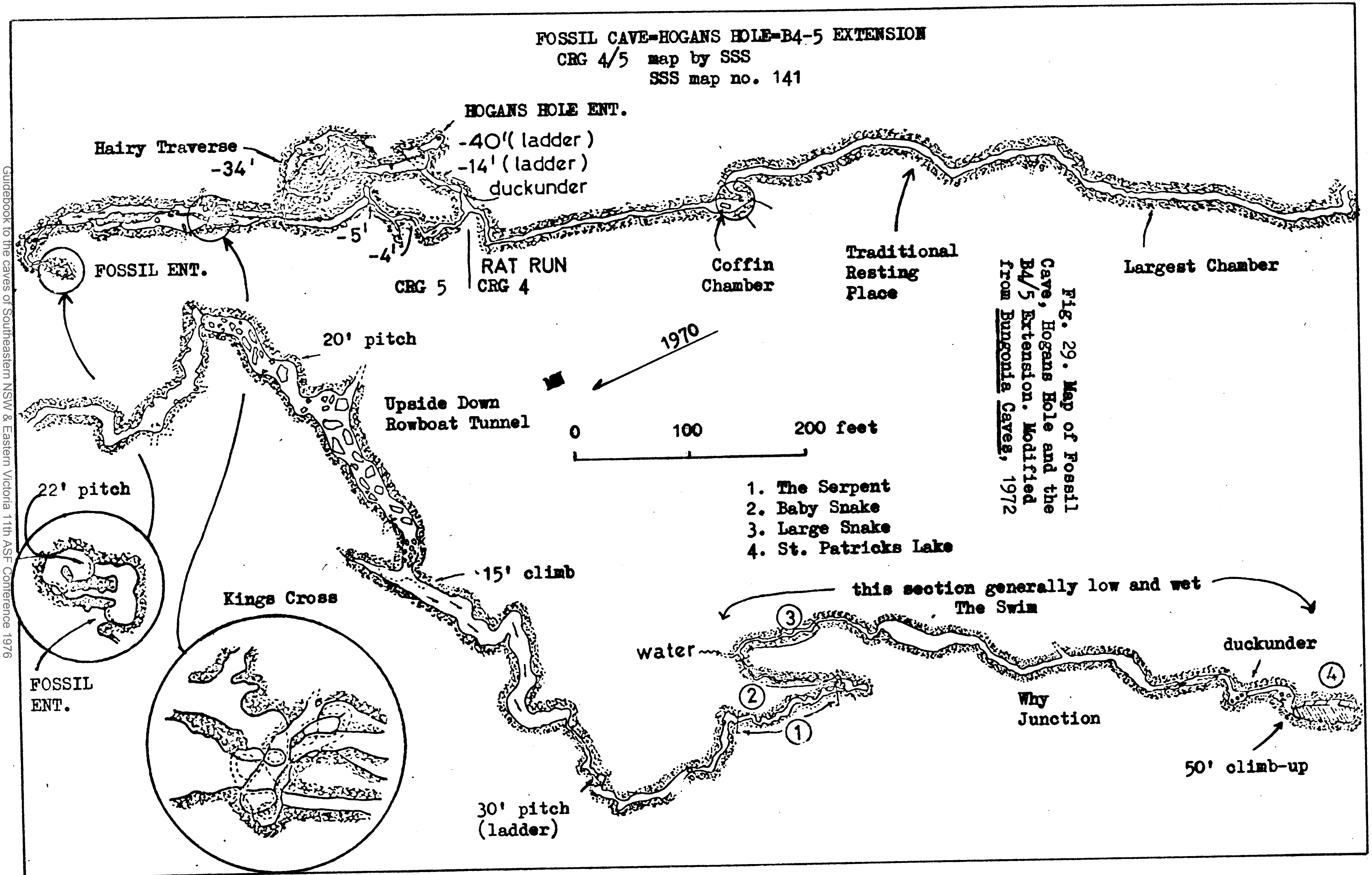


Fig. 29. Map of Fossil Cave, Hogans Hole and the B4/5 Extension. Modified from <u>Bungonia Caves</u>, 1972

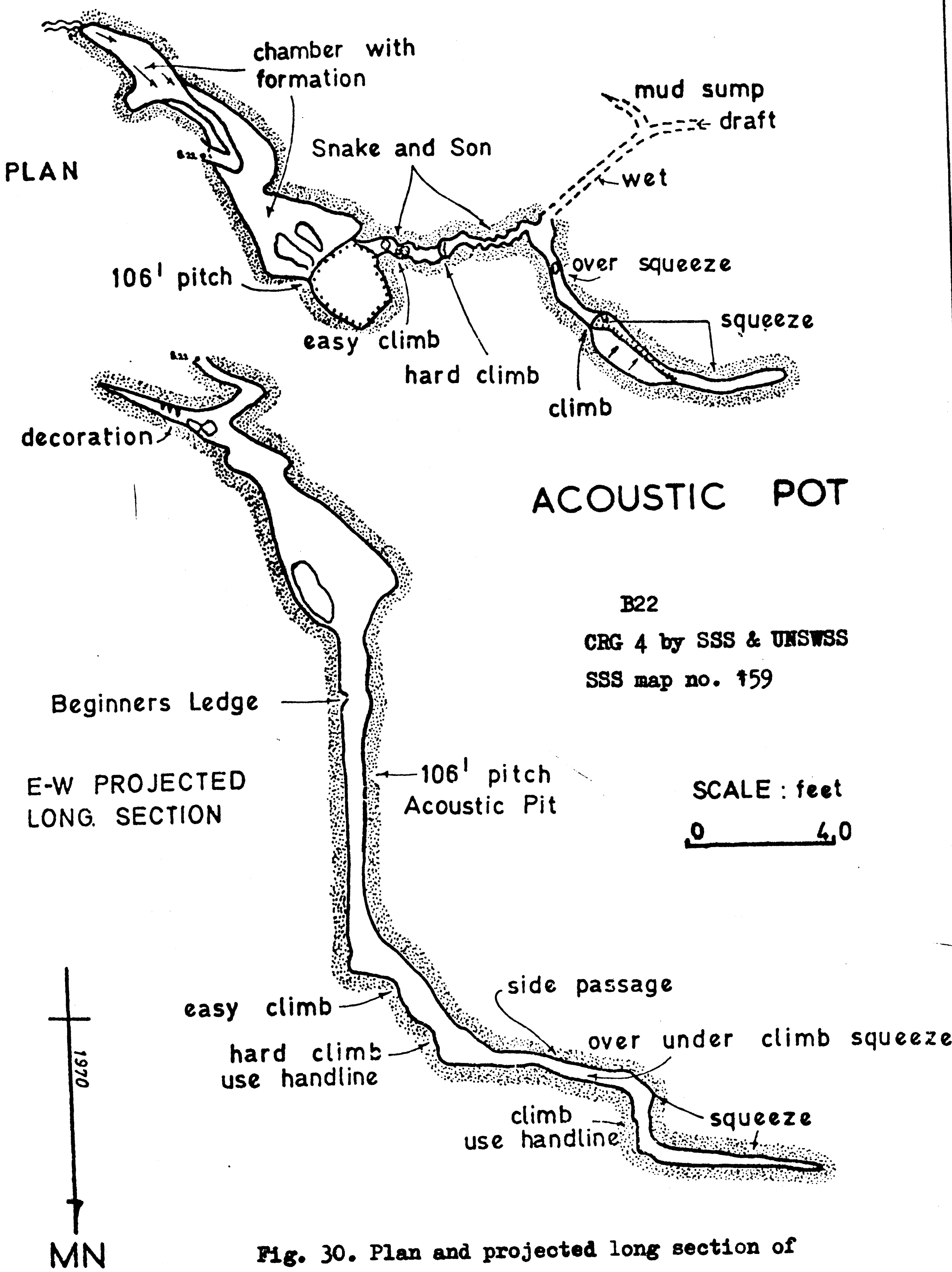


Fig. 30. Plan and projected long section of Acoustic Pot. Modified from Bungonia Caves, 1972.

in 1967 after mist was seen rising from under rocks. A tight tortuous crawl leads to the first chamber above 1st pitch.

WARNING - Do not shout too loudly in this section of the cave. This cave is unique and has exceedingly good echoes. Excessive shouting at this stage will cause a large pile of used words at the foot of the pitch to collapse and shatter your eardrums. Before the pitch is rigged try tossing a rock down - the effect is startling. From the foot of the first pitch run various passages which can be explored.

Argyle Hole (B31)

Time : 8 hours   Walking Time : Park near entrance

Gear: 1st pitch - 20 m ladder, 1 trace, 40 m rope.
2nd pitch - 30 m ladder, 2 traces, 60 m rope.
3rd pitch - 20 m ladder, 3 traces, 40 m rope.
4th pitch - 10 m ladder, 1 trace, 20 m rope.
5th pitch - 40 m rope handline.
6th pitch - (to sump 2) 30 m ladder, 3 traces, 60 m rope and short handline.

Photography: limited to passage/climbing shots

References: Bungonia Caves.
Pavey, A. 1971. Spar 8 : 3-8

WARNING : beware of foul air.

The cave is entered through a small hole at the lowest point in a depression on the western side of the lookdown road. The entrance was dug out by UNSWSS in 1960, but there were signs of previous entry in the 30 m long and 1-3 m high entrance chamber. It is believed the entrance was blocked for safety reasons about the turn of the century by Louis Guymer, a guide at Bungonia.

Twelve metres along the entrance chamber on the left is the start of "The Squeeze", which is 6 m long, 15 m wide and 20-25 cm high. The squeeze opens into a horizontal roofed chamber with a 2 m hole in the floor, leading to the corkskrew, the left hand branch of which leads up to the 2nd squeeze. The second squeeze is 12 m long, up to 60 cm high, and 1.2 m wide, with a pebble floor. At the end of the 2nd squeeze a 2 m deep floor canyon leads to the lip of the 1st pitch. Belay to jug hold in the roof. (At this stage a diversion can be made to "Coroner's Cavern". A 12 m ladder is required to drop down into the cavern which has a fine natural bridge. The passages leading to the top of the pitch are rather small.)

At the first pitch 20 m of ladder is required as there is a difficult climb at the foot of the 12 m climb and extra ladder is used to negotiate it.

Continue on down the rift passage to the top of the 2nd pitch, belay to the chock stone in the rift. From the foot of the second pitch a 1.5 m climb and short stream passage leads to the top of the 3rd pitch. Belay to the jug hold above head level. From the foot of the pitch continue to the junction. The stream turns left to sump 2. The way on is straight ahead. Climb up 1.2 m to the top of a tight rift, which is the 4th pitch. Belay to chock stone at head level.

From the foot of the 4th pitch, rig a 40 m handline for the 5th pitch, the "Staircase". At the foot is a 4.5 m diameter chamber which contains the terminal sump 1, and is the end of the cave.

If you haven't had enough, return to the Junction, and follow the left hand passage to the top of the 6th pitch. Belay to a large rock column on the right. Pitch lands on a ledge 6 m above a pool. Climb down to the level of the pool, and then along for a short while, and a 3 m drop is reached. Climb down and duck under the flowstone to a very difficult 3 m vertical squeeze which leads to the top of a 6 m shaft, at the foot of which is sump 2. The return up the vertical squeeze is impossible if a handline has not been rigged.

Hollands Hole (B35)

Time : 2 hours   Walking Time : park near entrance

Gear : none

Photography : limited

Reference : Bungonia Caves

This cave was first penetrated in 1968. The entrance is distinguished by its wooden cover and is situated in a large doline, on the right of the track to the Cow Pool near B84. It is outside the caves reserve and was dug out by R. Holland (SSS).

A 2 m entrance climb leads to a small chamber with stream passage going off at right angles. Half way along this passage a climb upwards leads to the "Root Chamber", containing tree roots and various decorations. Regaining the stream passage, follow until the "Hip Hugger" squeeze is reached. There are two sections to this squeeze, which opens into a 6 m long chamber. Behind a slab of rock a small passage leads to walking passage which finally goes to small passages and various squeezes and after an 8 m climb the terminal dig is reached.

Grill Cave (B44)

Time ; 3-4 hours.   Walking Time : Park near entrance.

Gear : drop to sump in Right-Hand Branch, 40 m rope.

drop to terminal sump, 5 m ladder.

Photography : limited

Reference : Bungonia Caves

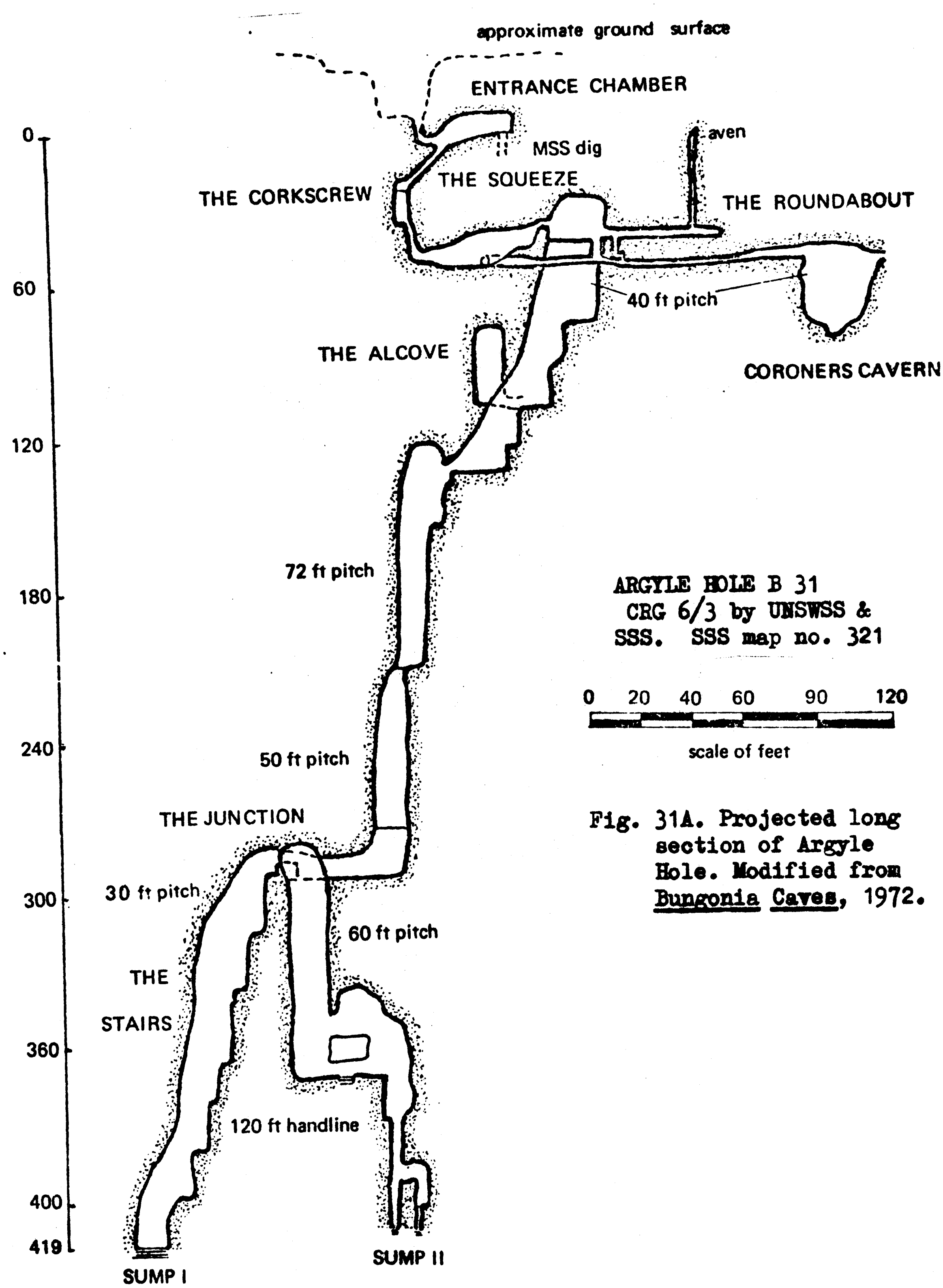


Fig. 31A. Projected long section of Argyle Hole. Modified from <u>Bungonia Caves</u>, 1972.

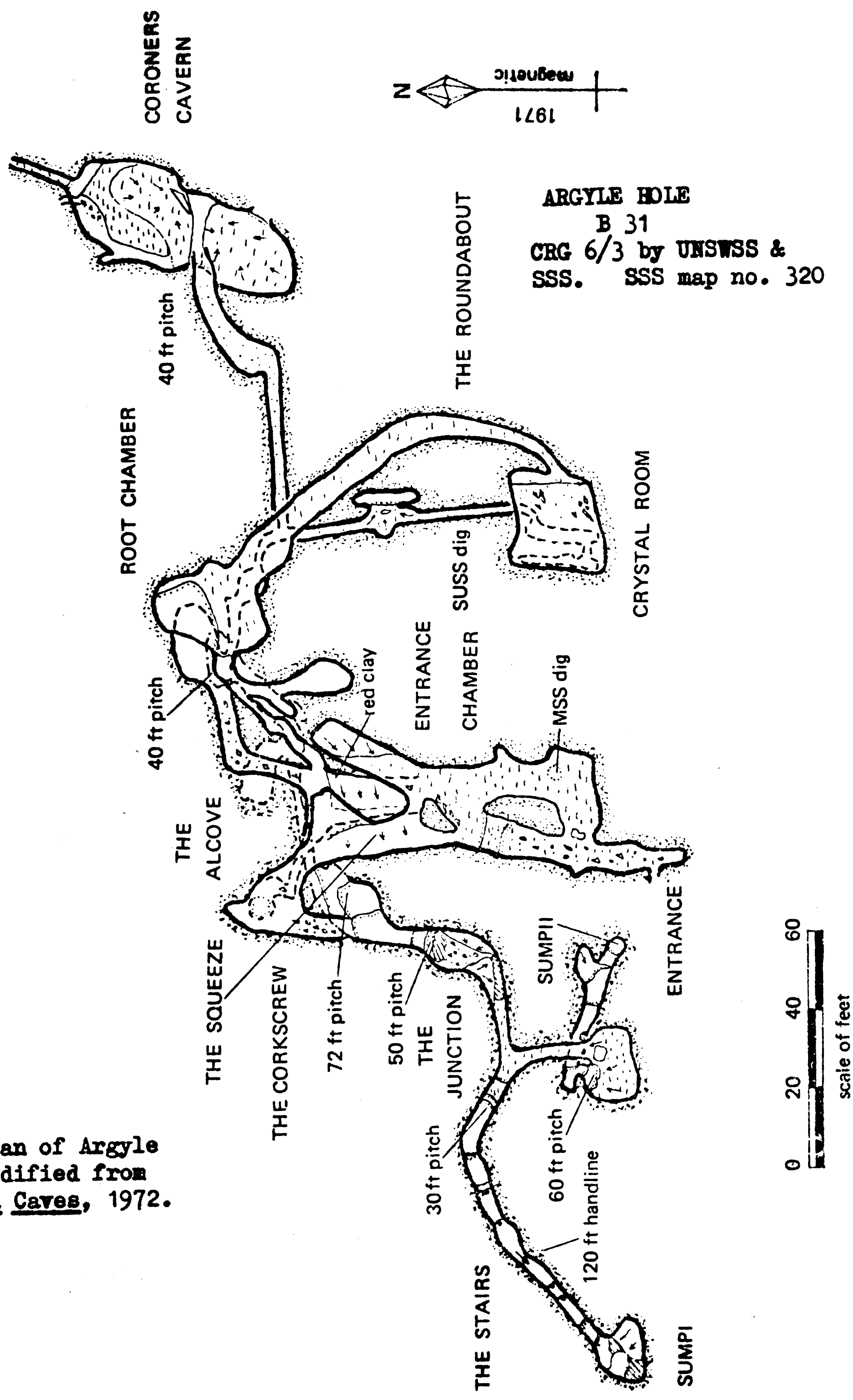


Fig. 31B. Plan of Argyle Hole. Modified from <u>Bungonia Caves</u>, 1972.

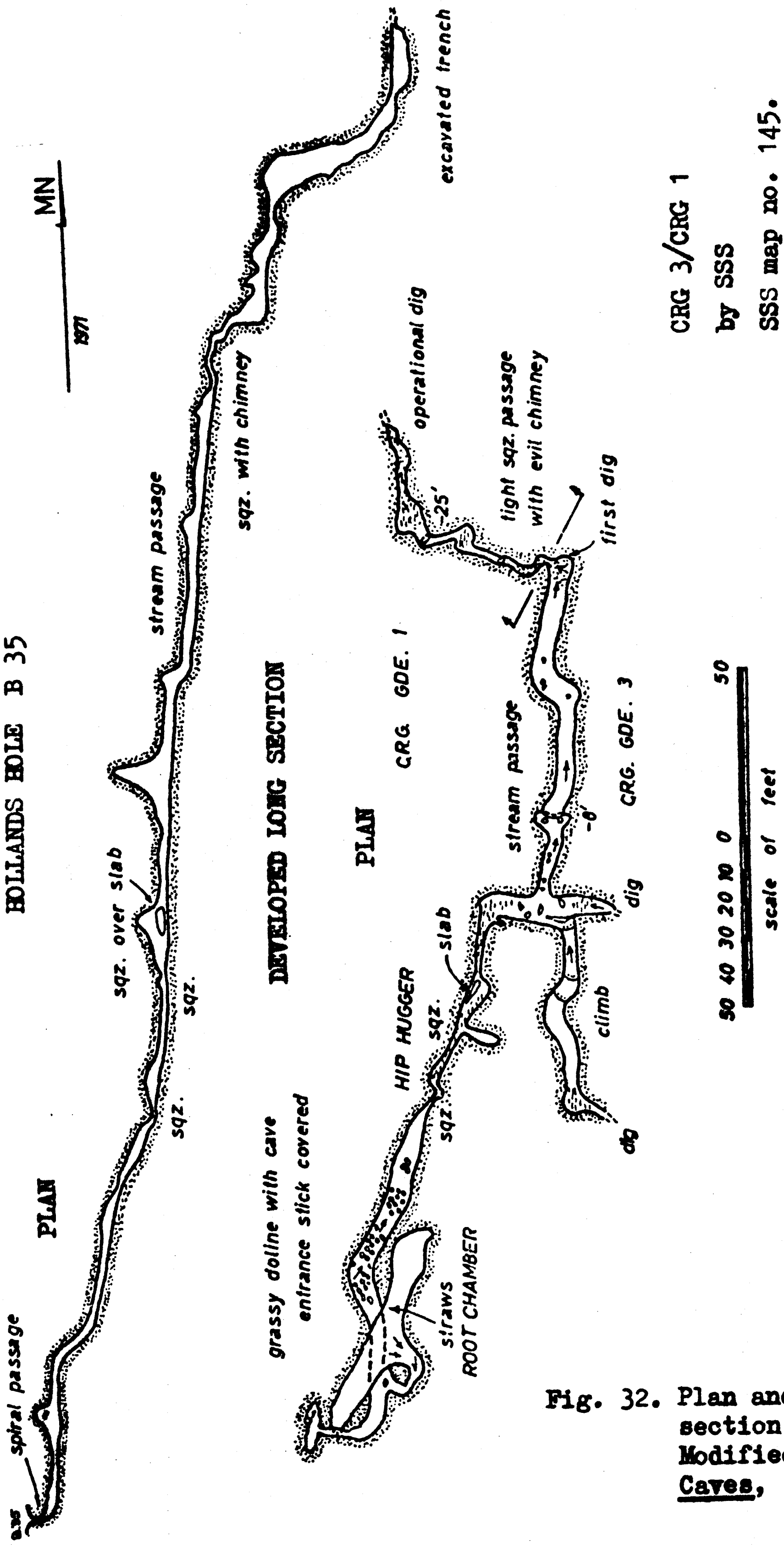


Fig. 32. Plan and developed long section of Hollands Hole. Modified from <u>Bungonia Caves</u>, 1972.

WARNING : Beware of foul air - especially in the lower sections. Grill Cave was one of the earliest known caves at Bungonia. It was already well known to the locals when Major Thomas Mitchell visited it in 1828. The ladders in the cave on the now removed "grill" over the main entrance were erected late last century and the cave was opened to the public.

The cave has two entrances in a large doline near the southern boundary of the Caves Reserve. B118 is at the bottom of the doline while B44, the one normally used on the south western side. This entrance leads to a medium sized chamber and the way on is by following the short iron ladder down from the northern end. This ladder leads to a longer one at the bottom of which, past a constriction, the B118 daylight hole can be seen 10 m above the floor.

From here the way is down the most obvious route, following the steel ladders. Soon a horizontal ladder spanning an 8 m drop will be encountered. The chamber here has a level floor of cobbles and small boulders and is about 12 m long and 9 m wide. From this chamber two routes, one up and one down, are possible to the next section. The routes converge again at the mudslide, the lower one at the bottom, the upper at the top. Not far down from here is the Crystal Palace, unfortunately though the area has been badly vandalised. Following down the low passage "Safe from the Russians" chamber is met. This chamber is large and the floor consists of boulders and blocks on a horizontal surface of bedrock. At the northern end a large rockpile is negotiated to a steep slope with a deep floor canyon. At the bottom of the canyon the chamber continues to a short climb down to the junction.

The Right Hand Branch leads via a low pressure tube and 2.5 m climb to a narrow bedding plane rift. From a chockstone the passage drops steeply to a small pool. The 40 m rope is needed as a handline for the descent to the pool. Use the chockstone as a belay.

The Left Hand Branch leads to a rockpile which can be negotiated in several places. The floor canyon drops in a number of steps to a small chamber. An inconspicuous squeeze beneath a "foul air" inscription leads to a short low chamber, on the other side of which is a short climb down a rockpile. At the bottom there are several old rimstone pools, and beyond these a 3 m rift which requires a short ladder. At the bottom of the rift is a sandy floored chamber and from here the terminal sump is down a low mud floored passage.

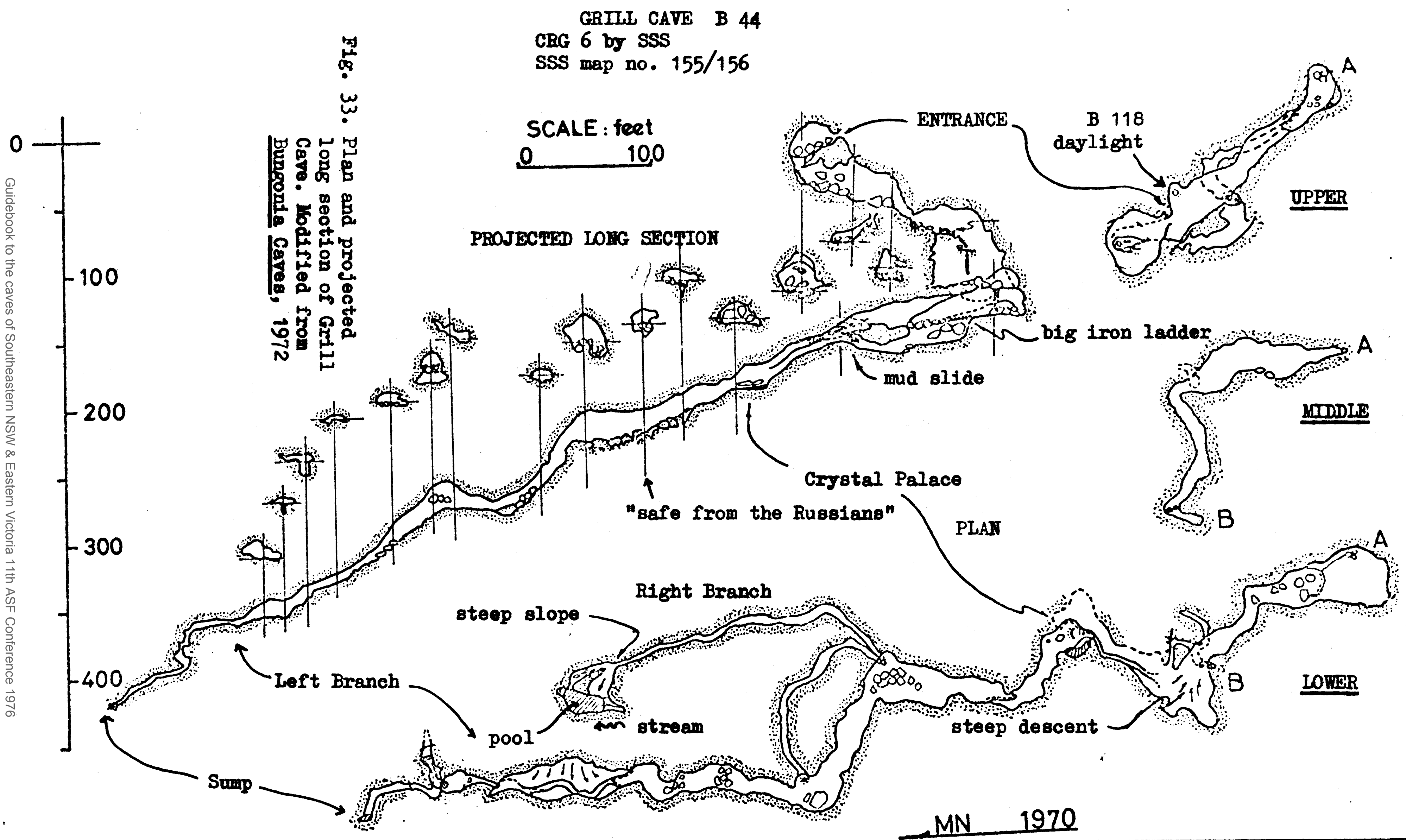


Fig. 33. Plan and projected long section of Grill Cave. Modified from <u>Bungonia Caves</u>, 1972

SOUTH COAST SEA CAVES

Systematic exploration of the Far South Coast for sea caves has only commenced in the last couple of years. Up until then isolated caves had been described (notably at Mystery Bay and Nadgee Nature Reserve by S.S.S.) but no method of numbering had been devised.

At the time of writing, the numbers allocated to (mainly) sea caves were I6M 1 to 38 (covering the Ulladulla 1:250,000 map sheet), J5D 1 to 25 (covering the Bega 1:25,000 map sheet) and J5H 1 to 54 (covering the Mallacoota 1:250,000 map sheet). An attempt has been made to have the numbers running North to South, but in the interests of having numbering up to date with published information, and not leaving gaps, numbers are allocated consecutively as cave details are recorded. As the entrances are so large, and easily located on maps, normal cave tags have not been affixed at the present time.

Sea caves are usually single chambers or tunnels, and thus lack the interest of limestone caves. The ratio of time spent underground to time spent getting there is fairly low in most cases. If ladder or rope work is required for entry, the pitches are usually on the cliffs outside.

Deciding what to call a cave is often difficult, as a complete range of openings occur. A rather arbitrary minimum size of 10 m has been decided, unless there is a significant reason to record a smaller cave.

Because of the mode of formation (mechanical breakdown rather than solution), the major element of structural control tends to be obvious. It can be a fault, major joint, dyke of softer more weathered material, bedding plane or the core of an anticline (sometimes with a single sandstone bed forming the roof). Some caves are at a high level, or well back from the sea and are no longer reached by waves. These usually have an earth floor and contain bats and a variety of other life. However, most receive a regular washing of at least part of the cave, and nearly all of it during rough seas. Sea cave exploration is not recommended if the sea is rough,as freak waves can be quite disastrous in confined places.

Systematic exploration can be a strenuous activity, as constant rock hopping, wave dodging and climbing up and down cliffs is necessary. The vegetation at the top can be quite thick (necessitating crawling under it at times), with ticks and snakes being fairly common.

Areas not yet extensively explored include Jervis Bay, Point Perpendicular, and south of Greencape Lighthouse.

Some suggested caves to visit are described below. In general, these are the largest and most complex and those with the easiest access. The groupings below are related to 1:250,000 topographic sheets, although location maps have been reproduced from 1:100,000 sheets.

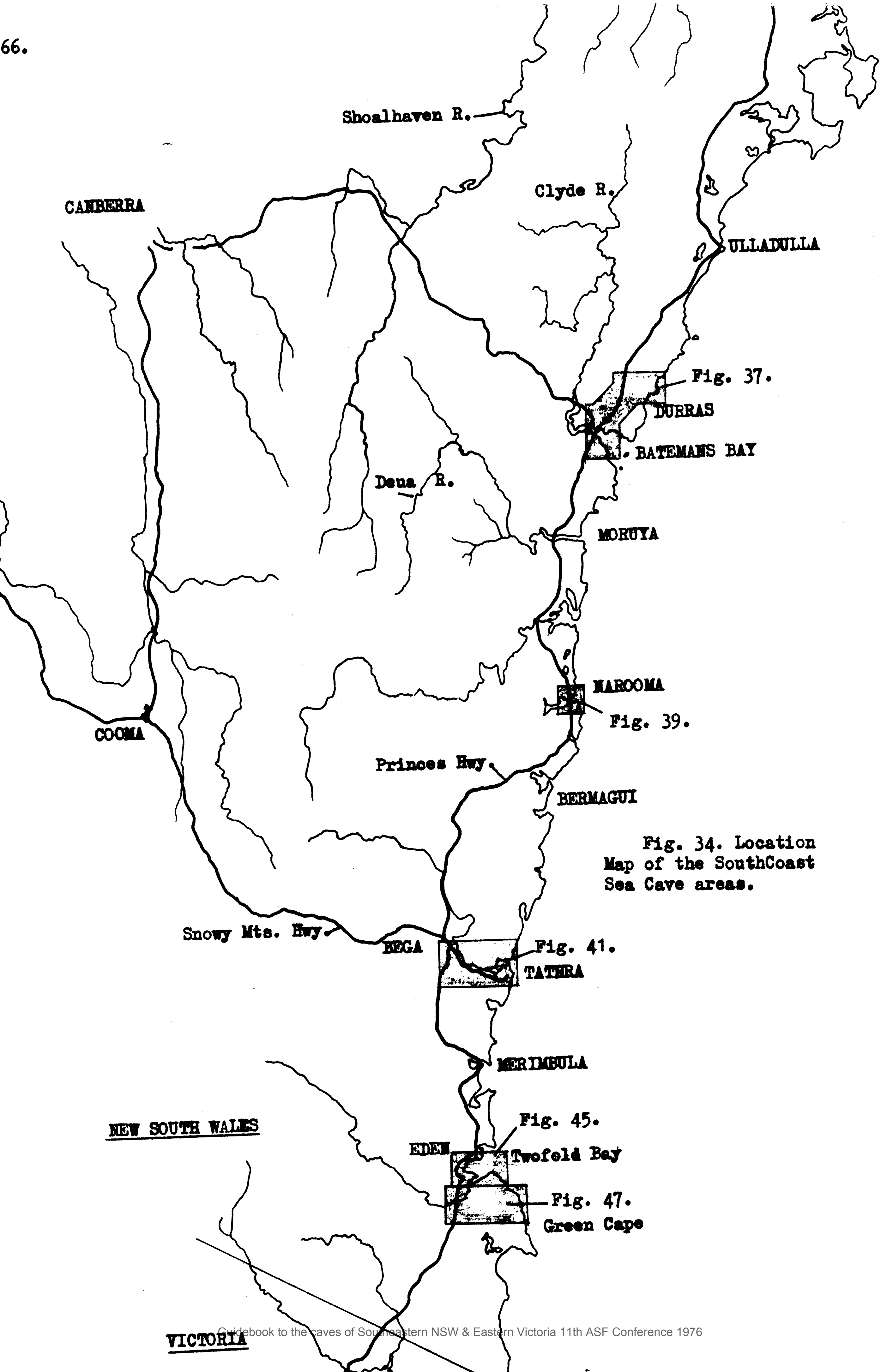


Fig. 34. Location Map of the SouthCoast Sea Cave areas.

ULLADULLA 1:250,000 SHEET

North Durras Cave (I6M2)

The cave is located below low cliffs behind a sandy beach, just north of North Durras Village (Fig. 37).

A complex sea cave with a tunnel towards the sea and another entrance through breakdown at the foot of the cliff. The 20 m diameter chamber has a flat floor and contains bats.

Snapper Island Cave (I6M20)

For those that like water. Alternatively you can use a boat. The large 20 m long tunnel is located on Snapper Island in Bateman's Bay (Fig. 37).

BEGA 1:250.000 SHEET

Paul Hogan Cave (Golfball gobbler) (J5D2)

This cave is located below the 2nd tee of the Narooma Golf course. Access is by climbing down the cliff (Fig.39.). It is a spacious (10 x 8 m) cave 60 m long. Flying golf balls outside the cave are a hazard, as a direct shot for the green passes over the entrance. The cave can be a good source of golfballs.

Avid television viewers may remember this cave as the one featured in Winfield Cigarette commercials.

Mogareka Inlet Cave (J5D14)

Mogareka Inlet cave is at the back of the beach just north of the Bega river mouth (Fig. 41.). The easiest access is across the river - or sand if the mouth is closed. The cave is 30 m long and has an earth floored chamber which was once inhabited. Remnants of a door are still present.

Tathra Cave (J5D 19)

Located in a cliff below the end of Tathra Street, Tathra (Fig.41.). The cave has a large entrance and leads back into the cliff about 22 metres. The roof is up to 4 m high. Both birds and bats are present.

MALLACOOTA 1:250.000 SHEET

Eden Fissure Cave (J5H 2)

Located on the north side of Yallumgo Cove opposite the fuel installation at Eden (Fig. 45). Access is difficult (i.e. wet) unless at low tide. From the large entrance (7.5 m high) the cave extends back some 38 m where the gravel floor meets the roof. Towards the inner end a narrow fissure can be seen in the roof. It has been estimated at over 15 metres high.

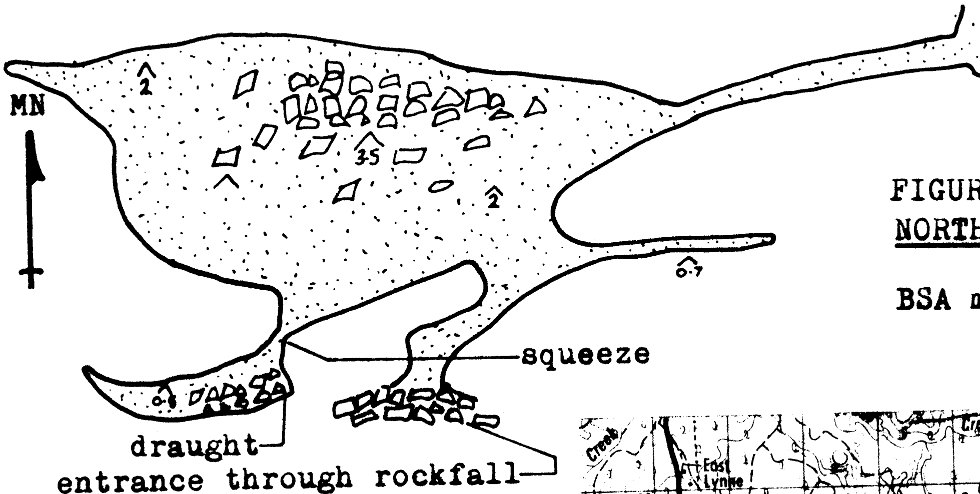


FIGURE 35.
NORTH DURRAS SEA CAVE
(I6M2)
BSA map 19. CRG grade 4
scale 1:500

Surveyed D.Moore, A.Vasey.
Drawn D.Moore, 1974.
Reproduced from
Bermagui Caver 2(1):7

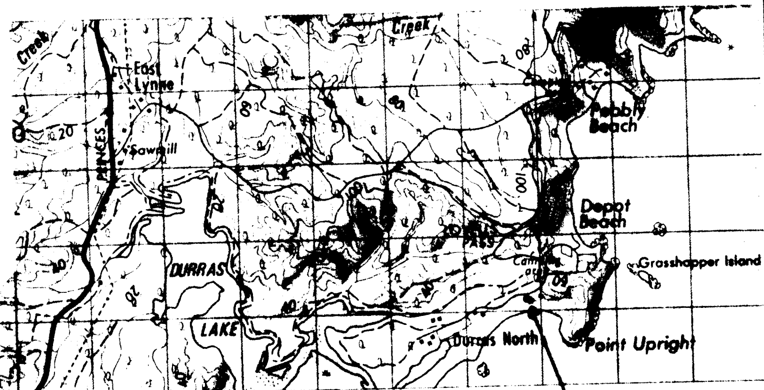
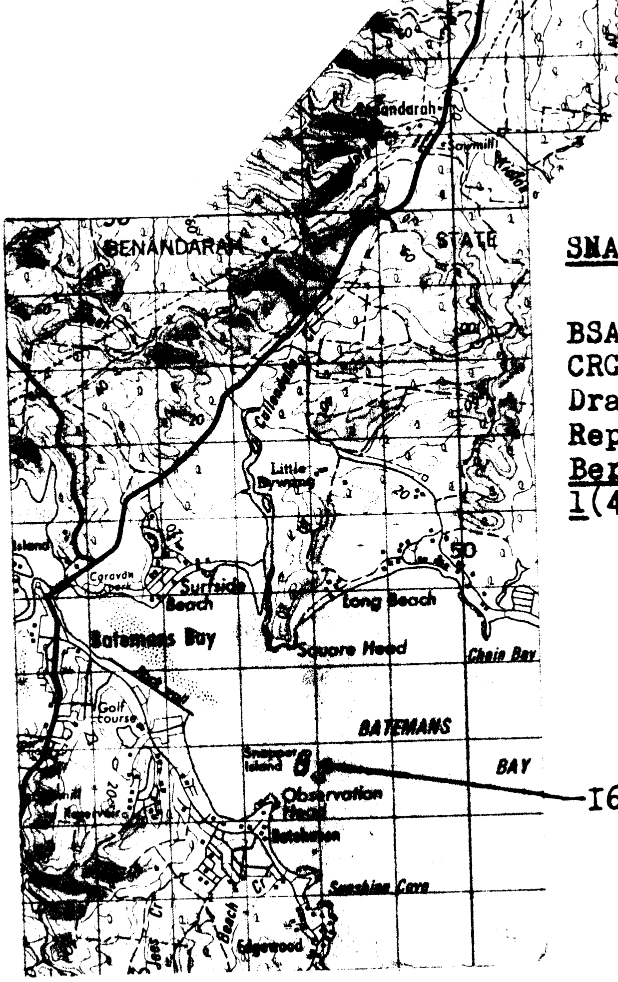
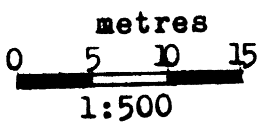



FIGURE 36.
SNAPPER ISLAND CAVE
(I6M20)

BSA map 17.
CRG grade 3.
Drawn J.Taylor,
Reproduced from
Bermagui Caver
1(4):10, 1974.

scale 1:500



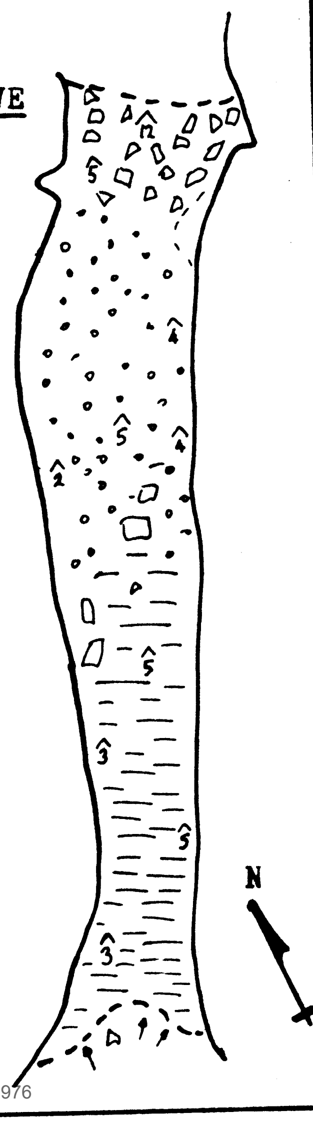


FIGURE 37 From Batemans
Bay 1:100,000 sheet.

An interesting feature is what appears to be flowstone covered stones just inside the entrance. They are exposed at low tide.

(J5H 14)

J5H 14 is the largest of several strike controlled sea caves below Edrom Lodge, south of the Woodchip Mill on East Boyd Bay (Fig. 45). The cave, which has four entrances, appears to have been used for storage at one time, as a flat platform has been carved out along the rear wall.

Red Point Cave (J5H 41)

Located 300 m along the coast southwest of Red Point, which is where the Ben Boyd lighthouse is located (Fig. 45). A large 28 m long cave with bedding plane roof and floor.

(J5H 31)

Located south of Mowarry Point (Fig. 47). The 30 m long cave is developed along a major joint which forms the northern wall at the entrance and the southern wall at the inner end. It has a low roof and a floor of collapsed blocks.

Entrance can be gained by the deep sea channel (wet) or a 9 m ladder from above (dry).

(J5H 37)

An interesting 30 m long cave on two levels. The higher level passage has a dry earth floor, while the floor of the lower chamber is debris and rock and has a pool at the inner end. A 3 m ladder is required for entry through the roof hole to the lower section.

The cave is located 200 m north of Saltwater Creek beach (Fig. 47). To get to Saltwater Creek take the Green Cape Road (off Edrom Road) for 2.5 km. Turn left along crossing road for 1 km to a "T" junction. Turn right and go along Duck Hole Road for approximately 3 km then turn left into Saltwater Creek camping area. The camping area is in Ben Boyd National Park.

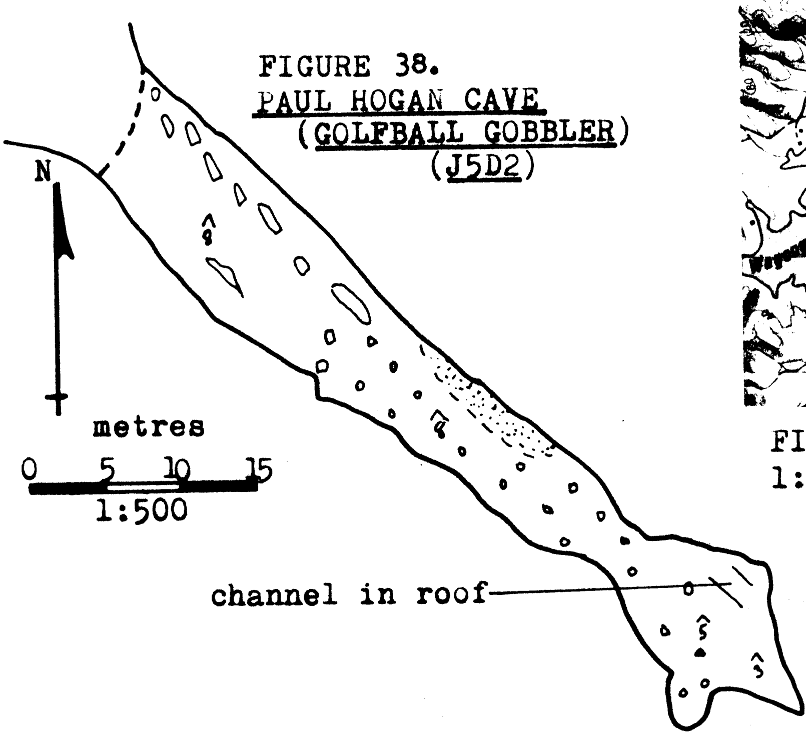
(J5H 38)

Located in cliffs south of Saltwater Creek (Fig. 47). A large cave 28 m long with a dry rock floor. Above high water level, it is used as a shelter by fishermen.

(J5H50)

Located 200 metres south of J538 (Fig. 47). This 65 metre long cave is particularly interesting. The cross section is somewhat varied, enlarging to a sandy beach at the inner end. Calcite decoration (gours, flowstone, columns) is present along the right hand inner wall. No cave map is available.

FIGURE 38.
PAUL HOGAN CAVE
(GOLFBALL GOBBLER)
(J5D2)



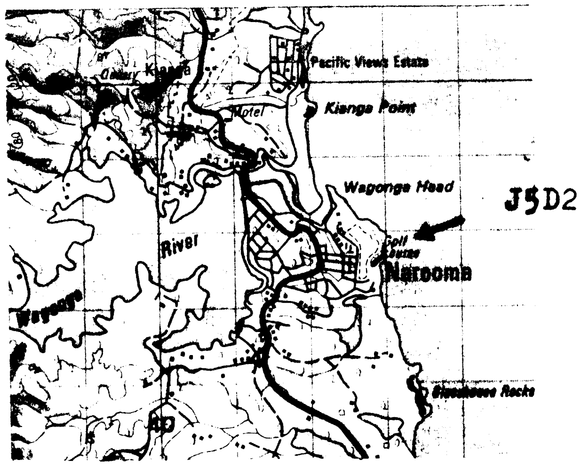
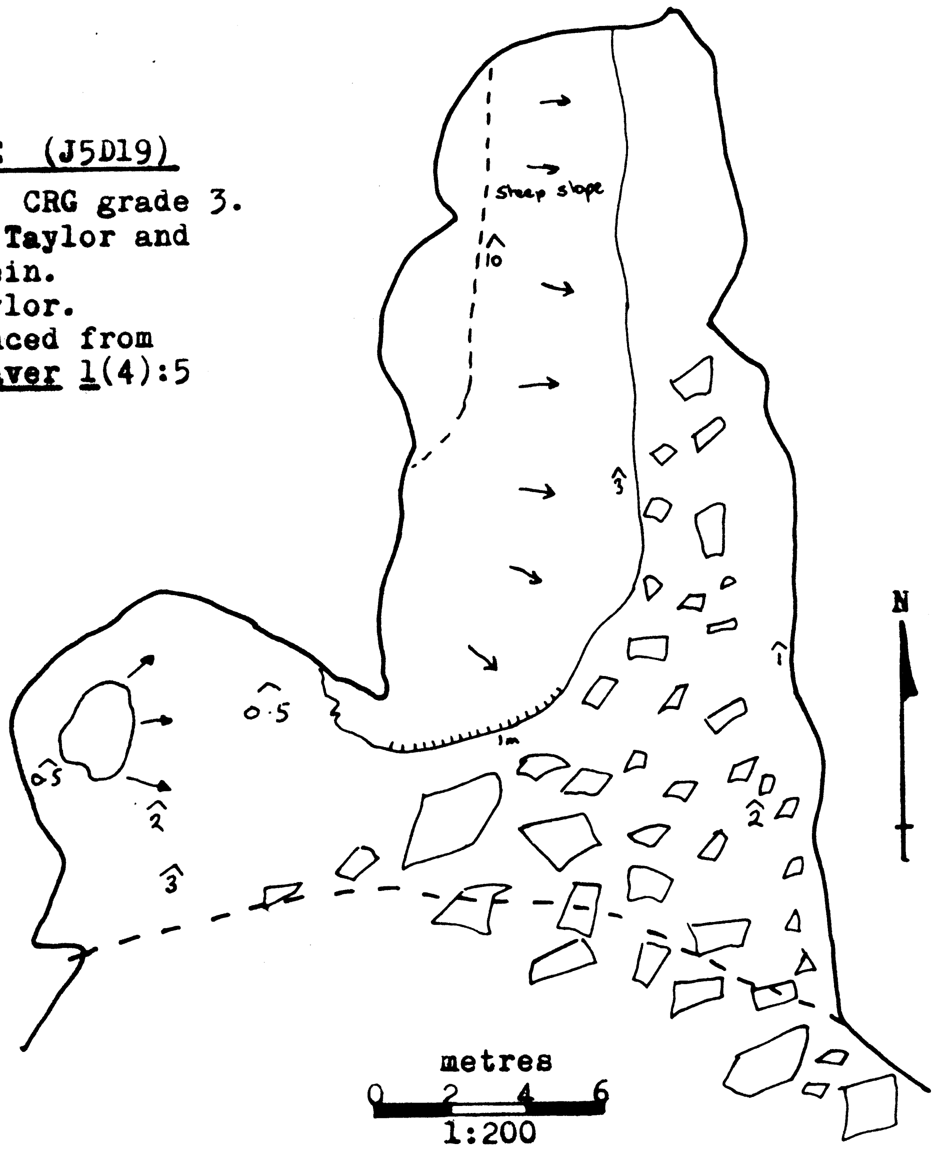


FIGURE 39. From Narooma 1:100,000 sheet.

BSA map 8. CRG grade 3
Surveyed J.Taylor, A.Vasey and D.Moore.
Drawn J.Taylor 3.74
Map reproduced from <u>Bermagui Caver</u> <u>1</u>(3):6

FIGURE 40.
<u>TATHRA CAVE (J5D19)</u>

BSA map 14. CRG grade 3.
Surveyed J.Taylor and D.Nichterlein.
Drawn J.Taylor.
Map reproduced from <u>Bermagui Caver</u> <u>1</u>(4):5



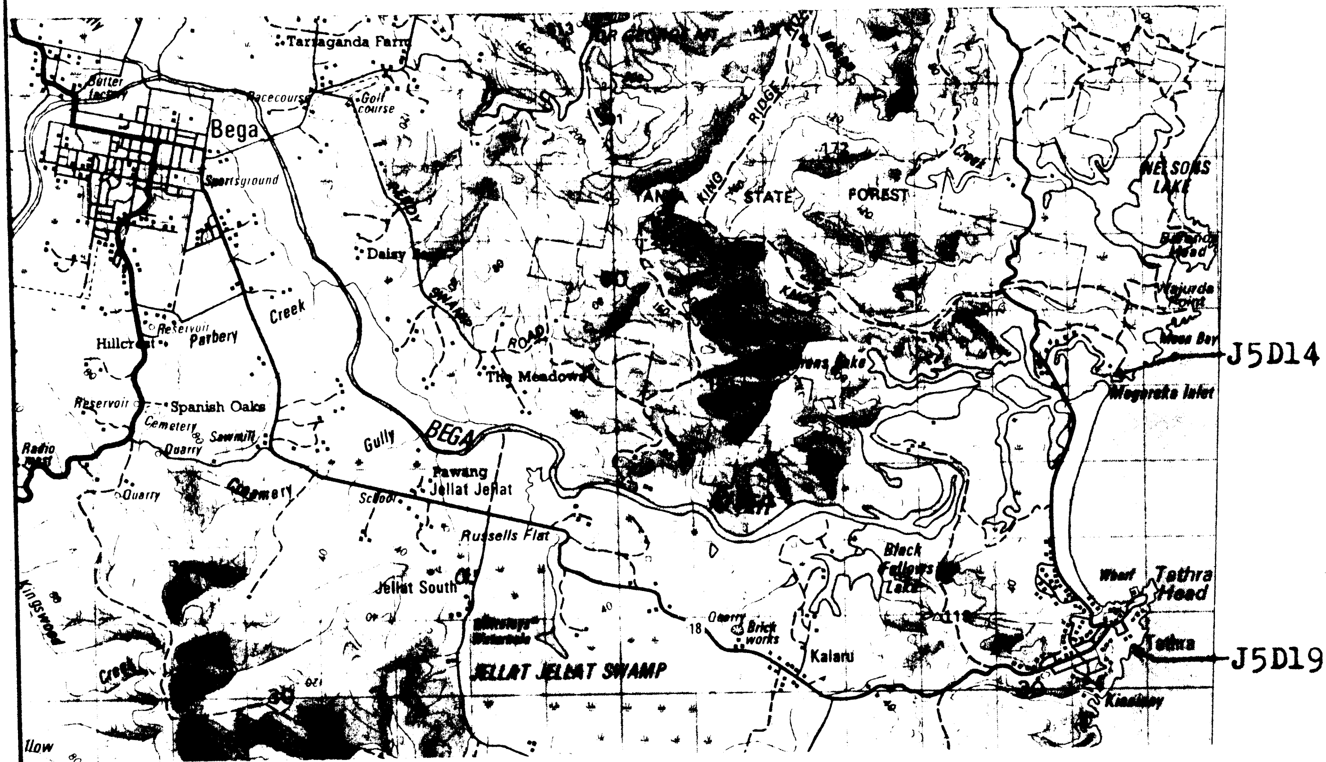


FIGURE 41. From Bega 1:100,000 topographic sheet.

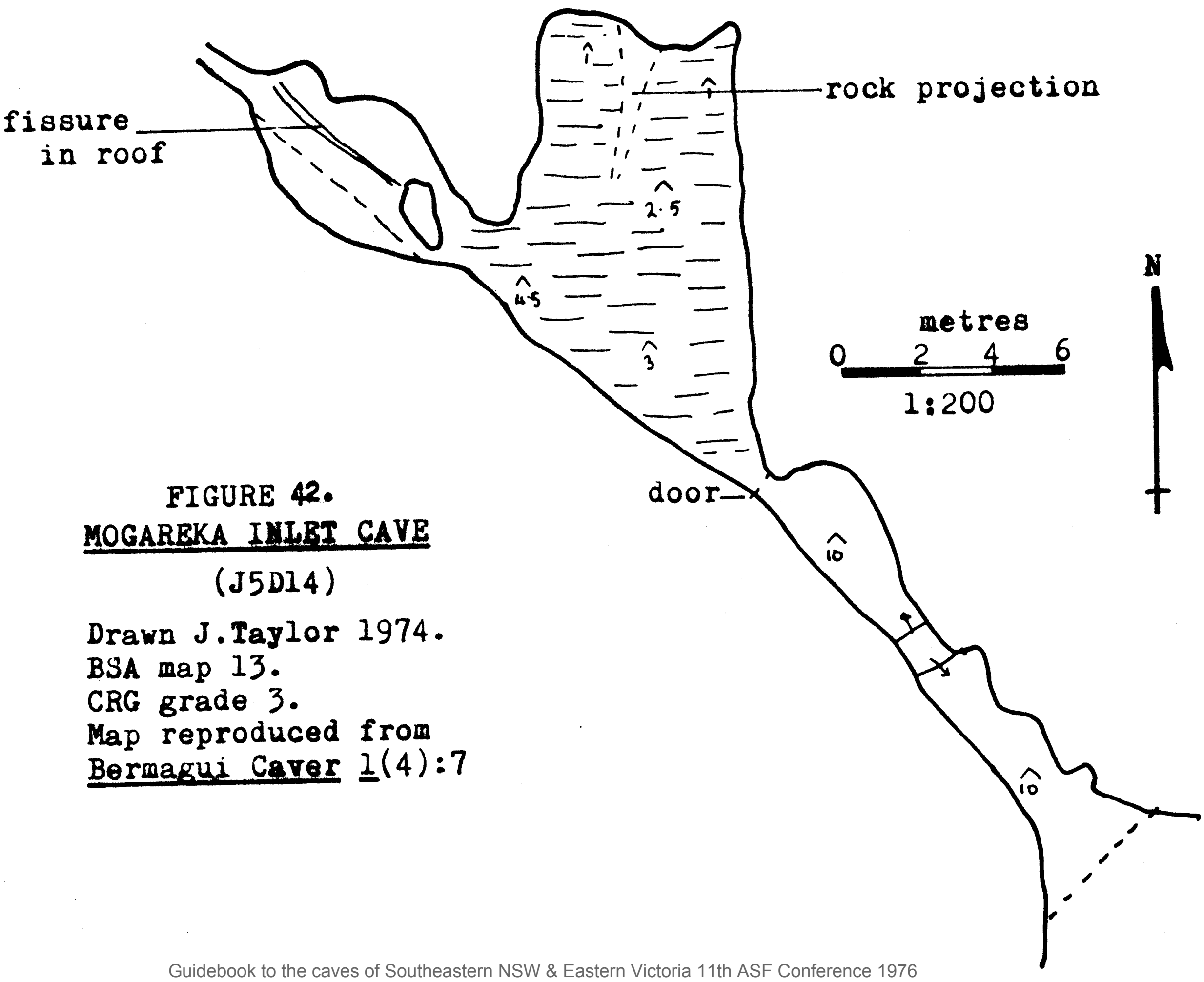
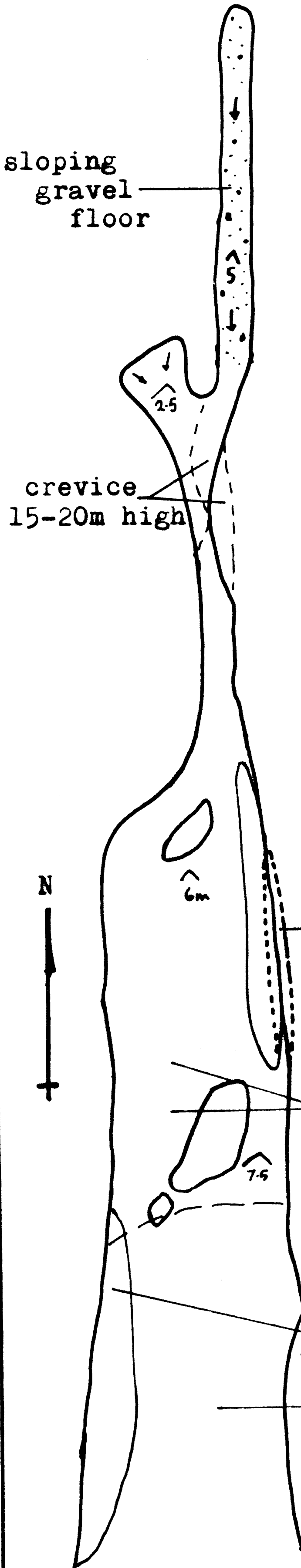


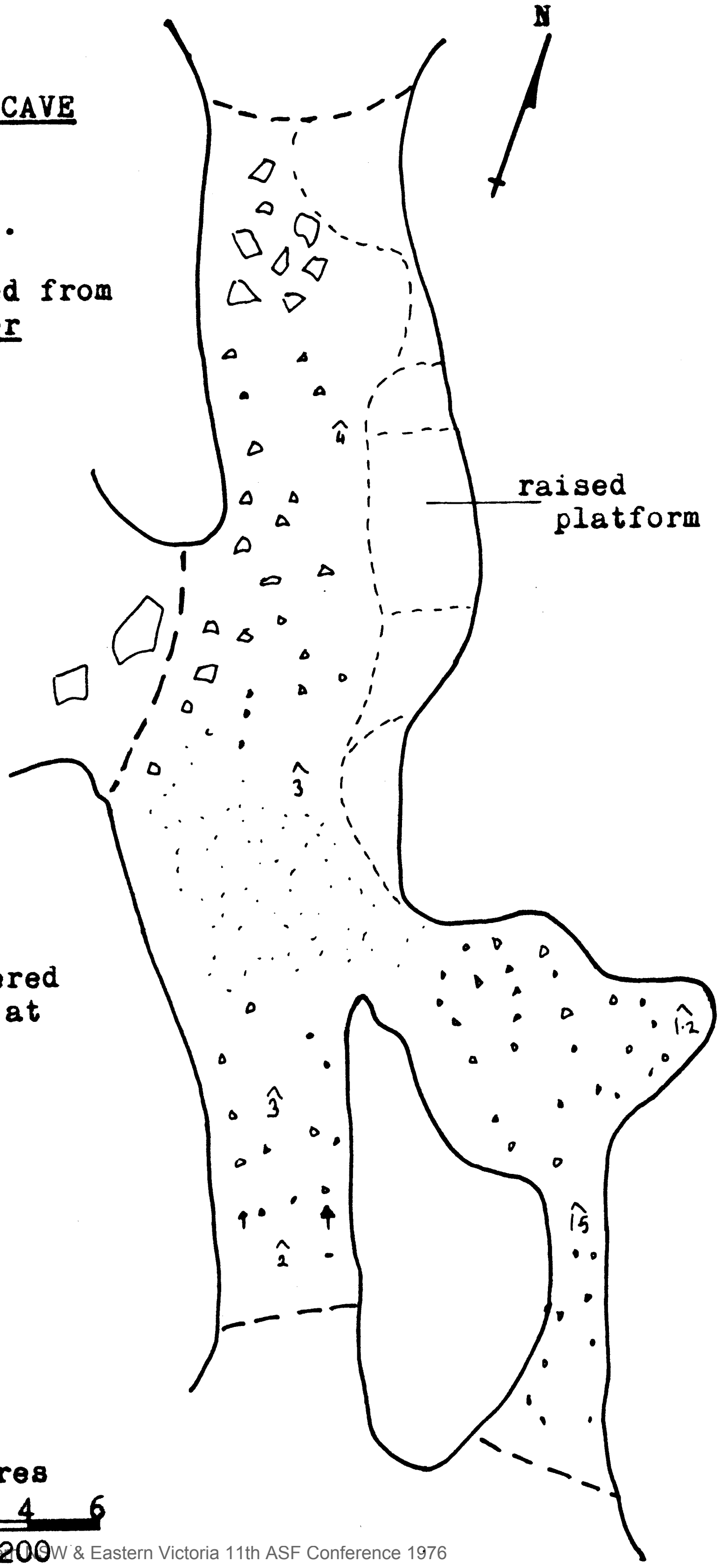
FIGURE 42.
MOGAREKA INLET CAVE
(J5D14)

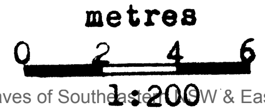
Drawn J.Taylor 1974.
BSA map 13.
CRG grade 3.
Map reproduced from
Bermagui Caver 1(4):7

FIGURE 44 J5H14
BSA map 32.
Drawn J. Taylor.
ASF grade M32
Map reproduced from
Bermagui Caver 3(1):9, 1975.

FIGURE 43.
EDEN FISSURE CAVE
(J5H2)
BSA map 6.
Drawn D.Moore.
CRG grade 3
Map reproduced from
Bermagui Caver
1(2):8, 1974.







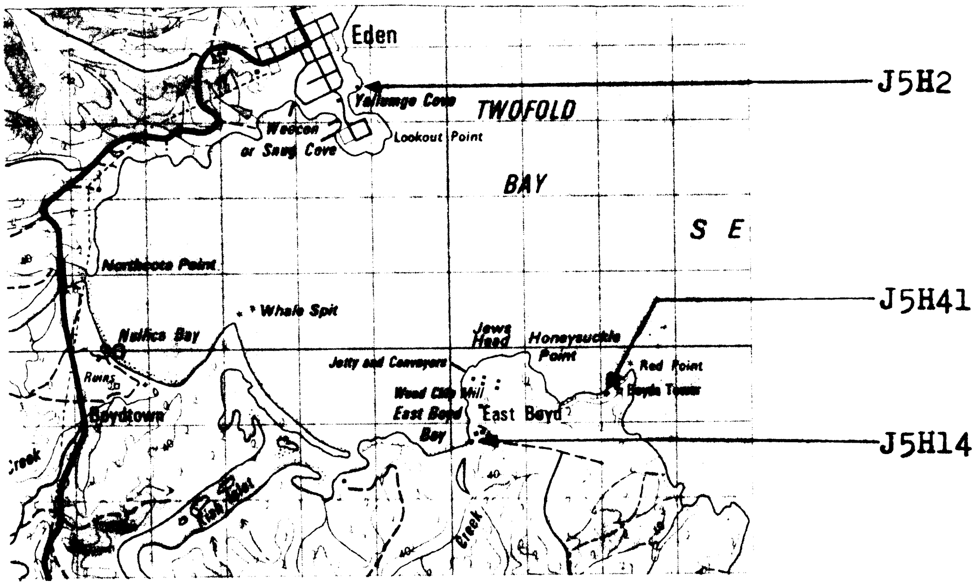
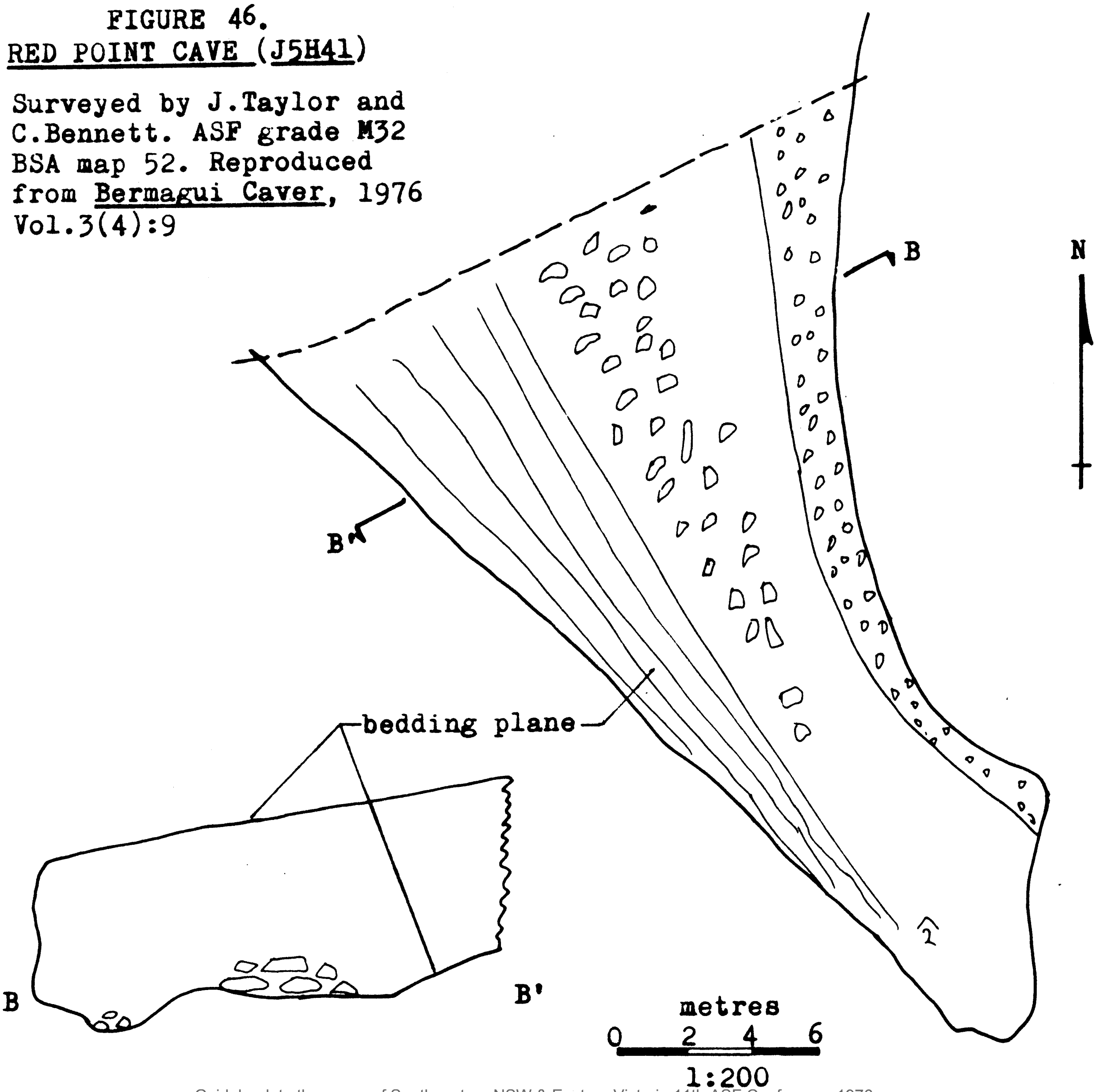


FIGURE 45 From Eden 1:100,000 sheet.
Southern edge joins Fig. 47.

FIGURE 46.
RED POINT CAVE (J5H41)

Surveyed by J.Taylor and
C.Bennett. ASF grade M32
BSA map 52. Reproduced
from Bermagui Caver, 1976
Vol.3(4):9



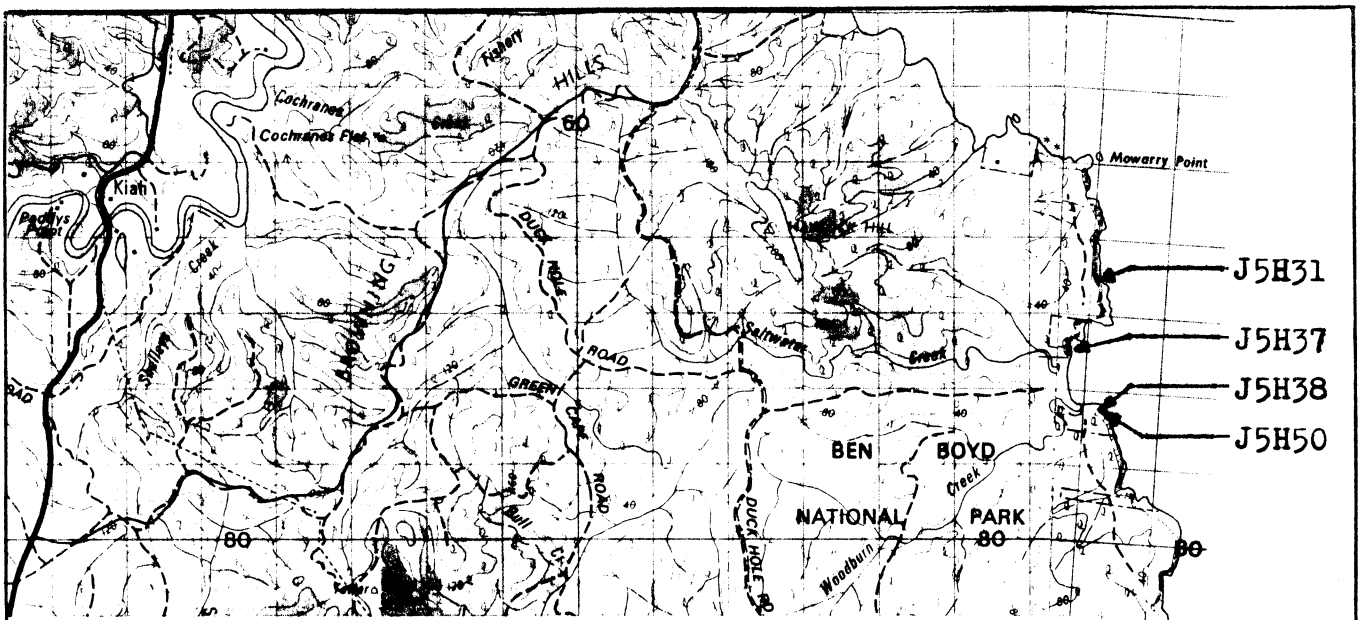


FIGURE 47. From Eden and Greencape 1:100,000 sheets. Northern edge joins Figure 45

J5H31 surveyed by J.Taylor and C.Bennett. BSA map no. 45. J5H37 and J5H38 surveyed by D.Nichterlein and J.Taylor BSA map no's48 and 49 respectively.Maps drawn by J.Taylor. ASF grade M32. Reproduced from <u>Bermagui Caver</u> vol.3(3):10-12.

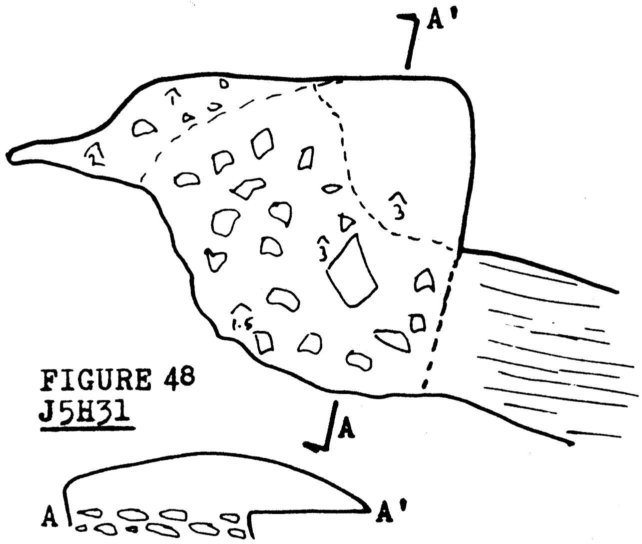


FIGURE 48
J5H31

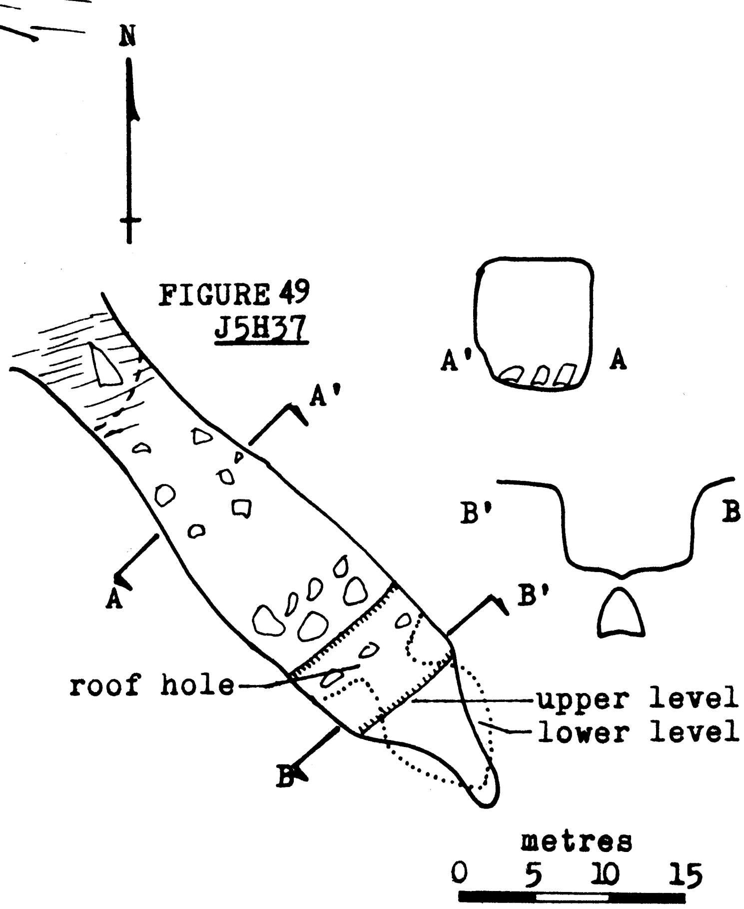


FIGURE 49
J5H37

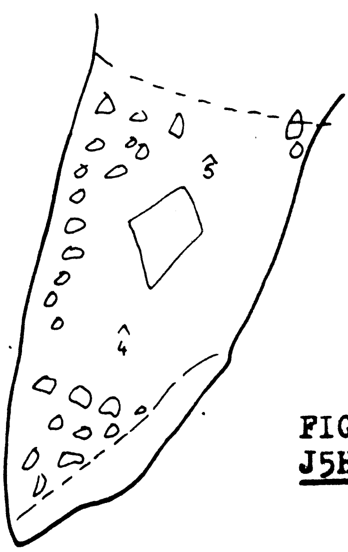


FIGURE 50
J5H38

BUCHAN, Victoria

Including East Buchan, The Basin, The Potholes, and Murrindal

Summary

The Buchan area contains a wide variety of interesting and significant karst features developed in massive Middle Devonian limestones. Three generalised types of cave are well represented: (a) vertically developed potholes; (b) predominantly horizontal stream passage caves, often with well decorated abandoned levels; and (c) substantial collapse caves with dramatic bedding-plane hanging walls. The caves vary in difficulty of access from long pitches, tight squeezes, and long low sumps; to walk-in standard. There are several areas of spectacular and interesting karst landscapes.

Transport

Buchan is readily accessible on good roads north from the Princes Highway, approaching either from Melbourne or from southeastern New South Wales. Alternatively, a very impressive scenic drive down the Snowy River Gorge from Jindabyne, or the Deddick and Snowy gorges from Delegate, gives access from the north on reasonably good mountain roads. Travel times would typically be in the 4-6hr range from Melbourne or Bega, and 5-7hrs from Canberra.

Accommodation

VSA currently uses two permanent establishments at Buchan, both managed by the Rimstone Co-operative. These are the old Buchan Hut, about 2km south of the town (35¢ per night), and "Homeleigh", in the town just north of the river, and within walking distance of the excellent pub and bakery ($1.50 per night). The former has a magnificent view; the latter has hot showers, gas stove, and refrigerator.

The Buchan Caves Reserve in the town includes a pleasant camping area with all amenities (including power for caravans) but is usually crowded around Christmas. There are several suitable places to camp in the bush - mainly to the north, around Murrindal.

Facilities in the town also include Post Office, service stations, cafe, and general store, but no butcher.

Cave Access and Co-ordination of Visitors

The majority of the caves at Buchan are either located on private property, or various small Crown reserves. In both cases, access to the caves depends on a carefully maintained relationship between the cavers and the landowners (and Lands Department). In a few cases, this relationship is rather precarious, but given a little consideration on the part of visitors, most of the landowners are prepared to co-operate.

It is of the utmost importance that visitors to the area adhere to all the principles of the ASF Code of Ethics, particularly in consideration of the interests of landowners. In addition, since this is a time of year when considerable numbers of tourists and campers frequent the district, it is important that cavers go about their activities discreetly, so as not to draw unnecessary attention to the location of caves other than the tourist caves.

VSA members will not be available in the district prior to the convention unless arrangements are made by writing in advance, or contacting Adrian Davey (03: 26 3252H, 267 1311W) or Tom Whitehouse (03: 91 1468H, 317 222x630W) in Melbourne.

For conservation reasons, no cave location information is included in this summary. Full details of the location of caves will be available to registered convention participants from the Superintendent of the Buchan Caves Reserve. He will require that visitors identify themselves, and will record name, address, club, and signature.

VSA operates a systematic documentation system for all cave visits. The co-operation of interstate parties is sought in obtaining a cave recording kit (kept at both the Hut and Homeleigh) and completing appropriate record forms for each caved visited.

The Buchan District

Geology

The geology of the district is dominated by a broadly folded sequence of Middle Devonian sediments overlying the Lower Devonian Snowy River Volcanics. The sediments include two series of massive high-grade limestones and dolomitic limestones of up to 300m thickness. The limestones extend over a belt some 20km long in the north-south direction, and 2-10km wide. The Murrindal River flows more or less down the eastern contact of the limestones with the volcanics. The Buchan Piver initially follows a similar contact on the west, but cuts across the limestones towards the east, to join the Snowy River.

Climate

The district has a temperate climate with moderate rainfall (around 850mm) with a slight winter maximum. Mean summer maxima of over 30°C produce effective drought for one or two summer months; while low mean winter maxima reduce the growing season by a further month or two. Flooding of the major streams is relatively common, with a slight summer maximum.

Vegetation

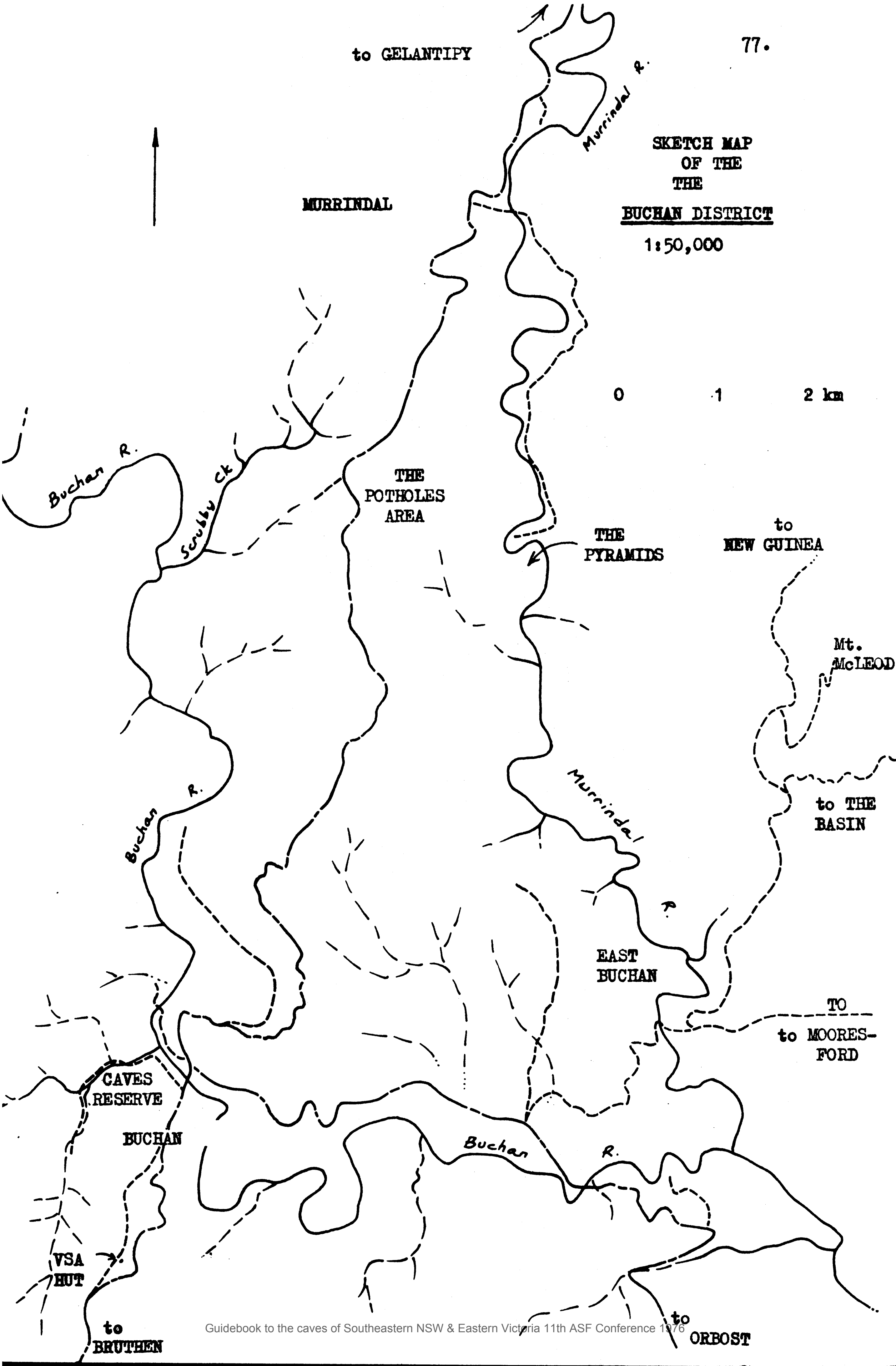
Most of the original vegetation on the limestones has been cleared. Remnants on the few areas of relatively undisturbed vegetation indicate that the structural form varied from open forest to woodland, probably dominated by Yellow Box (Fucalyptus melliodora), Red Stringy-bark (E. macrorrhyncha), Red Box (E. polyanthemos), Candlebark (E. rubida), Sheoak (Casuarina stricta), Kurrajong (Brachychiton populneum) and Pittosporum (P. undulatum). Wet gullies and some sheltered limestone cliffs harbour remnant rainforest species such as Lilly-Pilly (Fugenia smithii), Kanooka (Tristania laurina), Pittosporum, Milk Vine (Marsdenia rostratum), Lawyer Vine (Smilax australis) and Orange Vine (Eustrephus latifolius). Several extremely rare ferns occur on karst in the Buchan district: Binung (Cyclosorus parasiticus) occurs near carbonate saturated springs; and Chinese Brake (Pteris vittata) occurs in exposed limestone crevices.

History

Exploration of the district goes back to the 1830's, when stockmen from the Monaro first brought cattle down from the north in search of relief from drought. The earliest settlement was probably in the 50's when several large pastoral runs were taken up. The homestead at Murrindal dates from this period.

Mining occurred in the district on a minor but widespread scale. Several small lead-zinc or copper prospects in and near the limestones were worked from time to time. Remnants of an old smelter remain to this day below the Basin Road, on the Murrindal River.

The caves of the district have been known since at least the 1870's, and were probably well known to the aborigines (the name Buchan is said to be derived from Buckan-munjie: more or less - the place of the holes). By the turn of the century, several of the accessible caves were


SKETCH MAP
OF THE
THE
BUCHAN DISTRICT
1:50,000
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to GELANTIPY
Murrindal R.
MURRINDAL
Buchan R.
Scrubby Ck
THE POTHOLES AREA
THE PYRAMIDS
to NEW GUINEA
Mt. McLEOD
to THE BASIN
Murrindal R.
Buchan R.
EAST BUCHAN
TO
to MOORES-FORD
CAVES RESERVE
BUCHAN
Buchan R.
VSA HUT
to BRUTHEN
to ORBOST

already extensively damaged by vandalism. Following the report of a Lands Department surveyor, several known cave areas were then set aside as Reserves. The largest of these is the Buchan Caves Reserve. Relatively recent discoveries have indicated many caves of major significance which are outside these original reserves.

Marble quarrying has been an important activity in the past. A quarry at South Buchan provided high quality marble for several years, and was used in such places as Australia House, London, the Shrine of Remembrance in Melbourne, and the State Library.

Land Use

The main land uses of the district are agriculture and timber production. Agricultural activities are primarily grazing of beef cattle, and sheep for wool, with some dairying. Timber production in the district now comes mainly from forests outside the area, to two sawmills located near the town. Sources of sawlogs are chiefly the Timbarra River, the Snowy-Murrindal divide, and Gelantipy.

Quarrying is the only other local primary industry. APM operate a quarry for high-grade limestone used in recovery of pulp leachate at their Maryvale paper mill.

The caves, the nearby Snowy River, the scenic drives to Jindabyne, McKillops Bridge and Bonang, and the local rodeo all contribute to the attraction to the area of a substantial number of tourists each year. The tourist industry at Buchan has steadily increased in line with increasing community recreation time and travel. The district is within day-trip distance of the Gippsland Lakes holiday resorts, with very large summer populations.

THE BUCHAN CAVES

Several hundred caves are known in the district. Many of them fall into one of three broad categories:

(a) Potholes - These vary from simple shafts, to complex, joint-controlled, phreatic passages and fissures with numerous internal shafts and avens. They are usually relatively dry. Although many commence in a solution doline, others have hillside entrances. Some of these caves include very fine pitches, and are well decorated (including some magnificent helictites). Examples include: Honeycomb (M.41), Oolite (M.56), Exponential Pot (M.125), Baby Berger (M.14), Baby Pierre (M.12), M.65, and M.99, all in the Potholes area, Murrindal.

(b) Stream Passage Caves - Gently meandering (often joint controlled) horizontal stream passages, some with dry upper levels containing extensive decoration. Some are very wet, with impressive sumps and long wet crawls. Examples include: Royal Cave (B.6), the Moons Cave system (B.32 - B.2), Dukes Cave (B.4), Trogdip (EB.10), Scrubby Creek Cave (M.49), Lilly Pilly Cave (M.8), M.4, Nuigini Namba Faiv Cave (NG.5), and the Dalleys Sinkhole - Sub Aqua system (M.82-M.35-M.26).

(c) Collapse caves - Developed by collapse into stream passages, in some cases with direct removal by an active stream. These caves often have rockfall entrances and complex pathways through them. Some contain very large chambers with spectacular bedding-plane hanging walls. Examples include: Dalleys Sinkhole (M.35) - an active river cave, Anticline Cave (M.11) - a vast "hangar" with a great anticlinal roof, Christmas Hall in Scrubby Creek Cave (M.49), the Trog Vaults in Trogdip (EB.10), and Federal Cave (B.7).

The examples given above serve to illustrate some of the more significant geomorphological and hydrological features of the area. It should also be noted that there are some particularly interesting surface karst landscapes in the district. The Potholes, with its concentration of solution dolines in generally cleared farmland, constitutes one of the most dramatic karst landscapes of its kind in south eastern Australia. The Pyramids, too, and the numerous cliffs along the Buchan and Murrindal rivers, are of great landscape interest. It is at the Pyramids that minor solution features, such as karren and solution pans, are best exhibited, but many of the exposed limestones in the district also have such features.

Caves of the district support several bat populations, of three species (Miniopterus schreibersii, Rhinolophus megaphyllus, and Myotis adversus). At least two of the caves are known maternity sites; a number of others may be of importance for acclimatisation of pregnant bats.

There is a rich invertebrate cave fauna. Some species, as yet undescribed, of oniscoid Isopods which occur in several of the wet caves, may turn out to be troglobitic. Interesting second level troglophiles include Notospeophonus castaneus consobrinus (Coleoptera: Carabidae), which is endemic to Buchan - Murrindal; and an as yet undescribed species of cave harvestman. One first level troglophile which occurs in significant numbers in several caves (but in very few localities other than Buchan) is the snail Elsothera funerea Cox (Mollusca: Charopidae). Cavernotettix buchanensis Richards (Orthoptera: Rhaphidophoridae), a cave weta, is a trogloxene confined to Buchan and nearby areas.

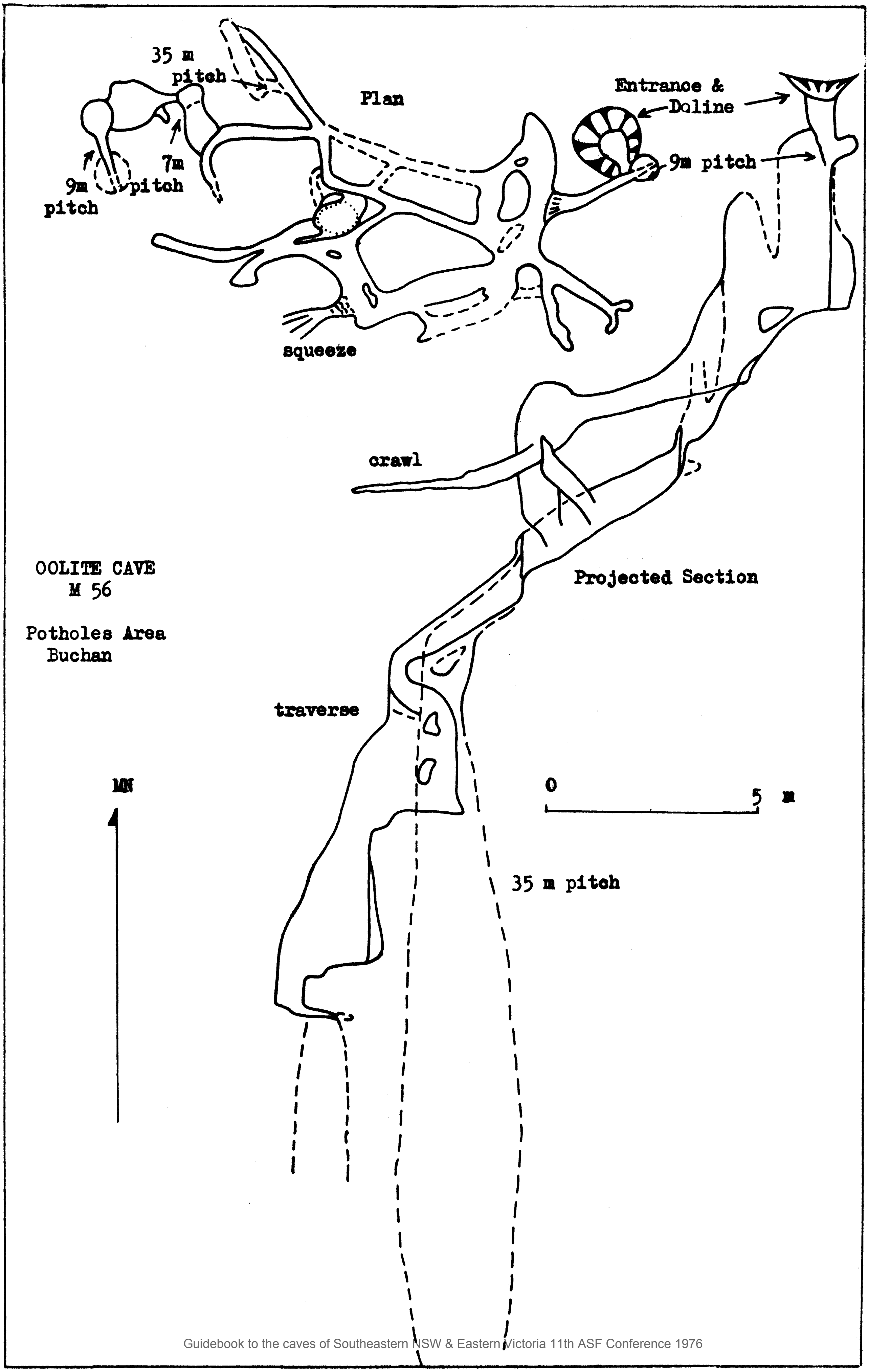
Several of the caves in the district have produced evidence of aboriginal occupation, dating back as far as 17,000 years. Of even greater significance, however, are the assemblages of sub-fossil material which occur in many caves. Excavation of some of these has already provided a great deal of information of palaeoecological interest. The assemblages include extinct species of such large mammals as Sthenurus, Zygomaturus, and Thylacoleo, as well as the Tasmanian wolf and devil, sea birds, seals, and a wide range of extant species of small mammals.

In gaining an appreciation of the caves of the Buchan district, a visit to the following caves is suggested:

Royal Cave (B.6) (Tourist cave, Buchan Caves Reserve)
Lilly Pilly Cave (M.8) (Tourist cave, Murrindal)
Wilsons Cave (EB.4) (A large stream passage cave)
Dicksons Cave (M.30) (A complex, joint-controlled, maze)
Oolite Cave (M.56) (A classic pothole)
Honeycomb Cave (M.41) (A pothole with an impressive maze of passages)
Dalleys Sinkhole (M.35) (A substantial collapse doline leading to a large active river cave and a large collapse chamber)
Trogdip (EB.10) (A classic horizontal stream passage system)

The two tourist caves contain a great deal of excellent decoration, and provide good examples of many features of the various caves at Buchan. Both are very beautiful. It may be possible to arrange some special trips into these caves. Wilsons and Dicksons caves have both been known for many years and are badly damaged. However, they are still worth a visit as they are very good examples of their type, and can be visited quickly and easily.

The last four caves listed are chosen to be representative of caves in the area, and are further described below. Other caves in the district which are well worth a visit in the company of a local leader (some require special knowledge, or safety precautions, or a key) include: Scrubby Creek Cave (M.49), Mabel Cave (EB.1), Hopes Cave (EB.14), Didgeridoo Cave (EB.17), Cloggs Cave (EB.2 - of archaeological interest only), Slocombes Cave (BA.1), Baby Berger (M.14), and Jampot (M.48). Please note that Anticline Cave (M.11) should not be visited during November-January, during the Rhinolophus breeding season.


35 m
pitch
Plan
Entrance &
Doline
9m pitch
7m
9m
pitch
pitch
squeeze
crawl
OOLITE CAVE
M 56
Potholes Area
Buchan
Projected Section
traverse
MN
0
5 m
35 m pitch

OOLITE (M.56)

Area: The Potholes, Murrindal
Time: A few minutes from car to entrance; typically 2-5 hrs underground
Equipment: 10m,10m, and 35m pitches, usually laddered

A short scramble into the doline leads to the top of the first pitch, it being some 10m and a little awkward. From the bottom of the pitch, follow down the fissure past a "duck under" dropping into a major fissure. Turn to the left for a little, then down to the right through a phreatic passage with old flowstone floor. A little further on, drop down a narrow slide, or chute (a little awkward getting up again) and follow round to the left. Down the next obvious fissure on the left a 8-9m pitch can be found after a little interesting chimneying and bridging. Straight ahead leads to the main pitch of some 35m.

Oolite is fairly typical of caves in the Potholes area, having rather fine phreatic passages and fissures, with more recently developed shafts extending to the surface.

HONEYCOMB (M.41)

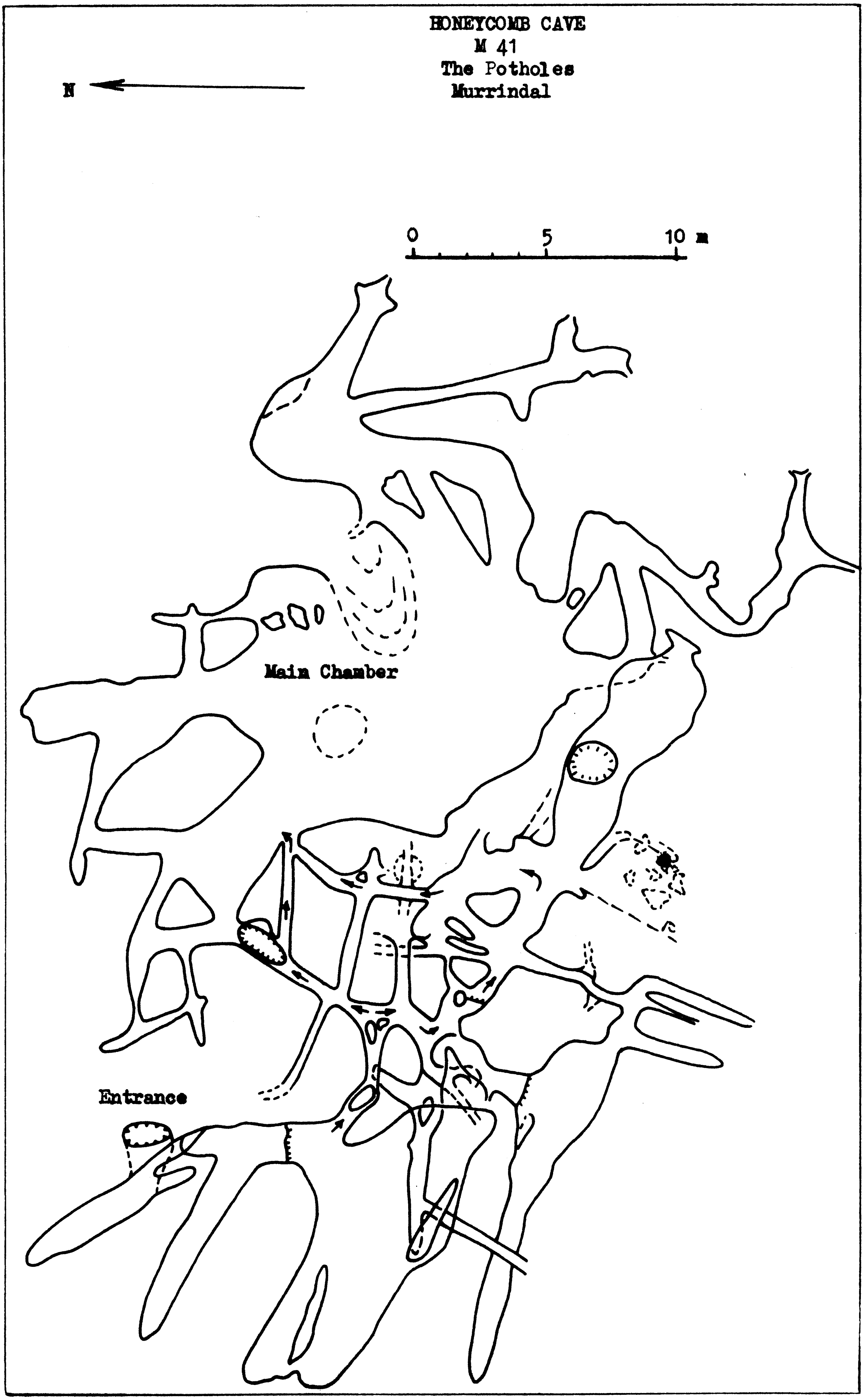
Area: The Potholes, Murrindal
Time: A few minutes from car to entrance; typically 2-5 hrs underground
Equipment: 10m handline for entrance
pitches of 50m can be rigged in the lower sections, but are not needed to visit the bulk of the cave

Descend the 9m entrance shaft with the aid of a handline. At this point, looking back up the shaft, a passage goes away down to the left. At the end of this is a vertical hole 2m deep. Slide down this, taking note of the holds for the return. Continuing, there is another 2m drop; beyond this, turn left and climb slightly down over the rocks to a T junction - there are two possible ways on from here. The heroes turn left, and after a few metres come to a 6m deep hole - better traversed rather than jumped. On the other side, a short crawl leads to another T junction; turn left, leading into the bottom of the main chamber.

Returning to the first T junction, the more cautious caver turns right. A few metres on, at an old survey mark, he turns left and goes down. Continuing on leads to a 30m shaft. Turning left then leads to the bottom of a high chamber; continue ahead over the rocks, up the mudslope, and almost make a U-turn to the left. From here, take a crawl to the right that leads upward, and at the top of this is the base of the main chamber.

From the main chamber, a number of interesting passages lead off. Imagination, ingenuity, and agility, are the main limits. Honeycomb was once an extremely beautiful cave but unfortunately is well known and has been over-trogged. Please exercise the usual care to preserve what is left.

Warning: Beware of large drops off the south side of the main chamber (on the right as you enter).


HONEYCOMB CAVE
M 41
The Potholes
Murrindal
N
0
5
10 m
Main Chamber
Entrance

DALLEYS SINKHOLE (M.35)

Area: The Pyramids, Murrindal
Time: ½hr walk from car at main road, or (dry weather only!) drive through paddocks; typically 3-6 hrs underground
Equipment: Handline for entrance

Warning: This cave is a quite active system, and is still very loose. Large rocks have been known to fall from the roof without warning. The original entrance to this cave collapsed, and the entrance rockpile is currently held up by one large rock which appears to have very little support. Before entering the cave, poke your head just inside the entrance and take careful note of this rock - a prominent triangular rock jutting out and providing what appears to be an ideal foothold. Use a handline to get in and out, and you are advised not to use the rock as a hold of any kind.

From the entrance, clamber down the obvious slope. At the bottom on the left is a small passage with an iron bar above it. Crawl into this and then turn right. A few metres on, this passage appears to end. The way on is up to the left. This leads to a large sloping rock which descends in steps for some distance. Down at the bottom, drop down on the right and turn around, walking along between two rocks until the passage opens out into a large chamber. From the rock platform, jump the gap to another platform. At this point the ways to the upstream and downstream sections of the cave diverge.

To go upstream, descend from the platform, and head back (past the first platform) through and over the large rocks until the stream is reached. The cave continues for a long way upstream, and is well worth exploring fully - no further description.

To go downstream from the platform, turn right (around the wall) and go up into a passage. Follow this, keeping at about the same level until you come to a small chamber which is slightly to the right as you enter it. Climb down here, and continue on for a short distance, through a hole, and then down the slope at the bottom of which is a sandy beach. This is the start of the downstream section, which is quite extensive (with some excellent side extensions) and is very interesting trogging - no further description.

Remember: Take care, this cave is still active.

While visiting Dalleys, it is recommended that an extra hour or two be allowed to permit a visit to the Pyramids nearby. This is an interesting and spectacular mass of limestone with numerous pinnacles and cliffs, a major collapse doline, and many fascinating minor features (such as karren, rainpits, solution pans, and so on). It also contains by far the best remnant of the natural vegetation on the limestones, including relict rainforest species, and offers a commanding view both up and down the Murrindal valley.

TROG DIP (EB.10)

Area: East Buchan
Time: 20 minutes from car; typically 4-10hrs underground

Trog Dip is an intermittent outflow cave which only flows after periods of heavy rain. It is remarkable for its abundance of low stream passage and the contrasting large chamber of the"Vaults" some 2/3 of the way through the cave. It has some 1400m of passage, being largely simple stream passage with a little complex branching at the end.

It is a good sporting cave, but with a largish party can be a slow cold trip, as much of it is low crawling, and at least partial immersion is required. It is thus recommended that some woolies be worn (especially if the third sump is open and a draught is running), not to mention carrying some food.

A trip through Trog Dip is relatively straightforward once through the rockfall and into the main stream passage. The main problem is that the third sump closes off after any sort of heavy rain, and remains so for some time, leaving a major portion of the cave inaccessible.

From the entrance, continue along a large open passage until confronted by the rockfall. Follow the right hand wall (facing inwards) and near the obvious "white" crystalline column turn right. This is followed by a bit of crawling and a few short climbs and squeezes past old gour pools, and then on through a triangular squeeze through rocks at the top of about a 3m climb, and eventually leads to the first sump. This is always open, about 50cm deep, with about 25cm air space.

Coming through the sump the main passage continues on to the right - the passage to the left leads into a narrow passage known as "Trog Sewers", which is quite confined, continuing for some distance and then sumping off at the end. Following the main passage, some fine "kneey" crawling leads to the second sump. This is probably always open also, being located in low (about 50cm high) passage with some 20cm of water and mud on the bottom. The route goes into the sump for several metres (not the end!), leaving through "The Hipcrusher" - a tight upward squeeze going up to the left. The next major feature encountered is the "Gravel Grovel", which will be more like a low muddy slither or "stick"(in the mud), for about 15m, some 20 -30cm high. If much, or any, water is encountered here it is probably advisable not to carry on, as the third sump which is not far off will almost certainly be closed.

A little past the "Grovel", a pool of water may be found where formation almost blocks off the passage. Carry on through the little space available, getting somewhat wetter. The third sump is just around a few bends, and is some 600 m into the cave. If the sump is blocked off, a very small triangular shaped passage dipping into the water is all that will be seen. In this case the only option is to turn around and go home.

If the sump is open, proceed into it for a short distance, then a little to the left up and over some flowstone, and into the "Kneebender" which leads into a small chamber with a little pophole in the roof. Go through this hole, and carry on a little eventually coming down a muddy ramp into the "Jaws of Death". From here the Trog Vaults are off to the right. The stream passage leads on further to some smaller chambers and branches into two rectangularly joint-controlled arms.

VSA would appreciate copies of any photographic material from the Vaults section of the cave.

CAVES AROUND CANBERRA

A paper to be presented at the 11th Biennial Conference of the Australian Speleological Federation at Canberra, 27-30 December 1976.

by

J.N. JENNINGS

INTRODUCTION

It was suggested to me that I should talk on this occasion about caves around Canberra as a means of illustrating general ideas about the origin and evolution of limestone caves. This has its problems, one of them being the difficulty of retaining the interest of those who, through long caving experience, have acquired a considerable background in karst geomorphology and hydrology whilst not assuming too much and digging too deeply in problematic matters for those who are beginning to build up speleological knowledge. My response to this will be to place a range of material before you - more in fact than I can present orally but which will be included in the excursion guide - so that you can pick and choose to suit yourselves and bring into discussion what you elect. I shall deliberately point to problems which still vex us or have eluded our attention. A second difficulty is that the variety of caves within the surrounds of Canberra is limited and alone would not allow illustration of all the basic principles which must be brought out for a sufficient framework of overall understanding. Where this arises, I shall make reference to the nearest examples to Canberra, though these may not justify being regarded as within its ambit and will not be visited after the conference.

REGIONAL CHARACTERISTICS OF IMPORTANCE FOR CAVE FORMATION

Initially I shall make a few generalisations about the nature of the caving areas around Canberra. First it is important to remember that we are dealing with tiny, impounded karsts, i.e. the body of carbonate rock is entirely surrounded by impervious rocks. So what goes on in the limestone is very much affected by surrounding areas. Large amounts of water are poured onto and into the limestone from outside, with particular chemical characteristics and with loads of foreign sediment of varied sizes. Generally these waters are aggressive towards limestone because they have carbon dioxide in solution which was not used up in reacting with the surrounding rocks such as the igneous rocks which commonly abut upon and surround limestone in our area. However in dry spells so much water loss takes place by evaporation and transpiration that these incoming waters may be rich in solutes and not very aggressive towards limestone since they already have much calcium and magnesium in solution. Nearly all the caves we are concerned with have deposits of quartz sand and foreign rock fragments which either are being carried through the caves currently or formerly were so entrained. Therefore mechanical attack on the rocks may be more important in our caves than in those of larger limestone areas.

We must associate with the first point the fact that precipitation is unreliable, both seasonally and from year to year, even though this is a part of Australia with a lesser degree of such unreliability than most. We have to reckon with prolonged droughts, which may last several years, and with prolonged and heavy rainfalls causing floods at any time of the year. Yarrangobilly and Cooleman Plain are also liable to occasional periods of long snow lie, the chief importance of which may be big flows of water if heavy rainfall combines with their melting as is sometimes the case.

All the areas are made up of strongly crystalline and highly compacted limestone or even more crystalline marble, generally of high calcite purity, all of low intergranular porosity but highly jointed and sometimes cleaved. It is on this fissuration that passage of water through these rocks depends. With this secondary permeability we must not forget that any notion of a watertable has to be a highly qualified one.

The limestones are of Silurian and Devonian age and they have been caught up in earth movements of Late Silurian and of Middle Devonian age, which have folded and faulted them considerably. Practically nowhere do we find them lying horizontally. This has the distinct investigatory advantage that more or less horizontal parts of caves are not likely to be a consequence of rock type and arrangement.

Despite the mechanical strength of the limestones with which we are concerned, they are more subject to attack and removal by geomorphic agents than many of the rocks which surround them, primarily of course, because of their greater solubility in natural waters. Therefore they are eroded differentially and tend to form lower parts in the relief than the surrounding impervious rocks. At Wombeyan and Cooleman, the Silurian carbonate rocks occupy small basins surrounded by higher plateau or ranges in igneous rocks. At Cooleman there is also an extension of limestone down the gorges of Cave Creek and the Goodradigbee River valley. This extension resembles the situation at Wee Jasper where Devonian limestones crop out along the bottom of the Goodradigbee valley and that of its tributary, Wee Jasper Creek, even though it does form the well-known but modest protuberance of Punchbowl Hill. Silurian limestone at Yarrangobilly again follows the valley line, recessed relative to igneous rock on one flank and other sedimentary rocks on the other. At Bungonia the relationships are less obvious because the local relief on the plateau is small; nevertheless the limestone strike belts are overlooked by gentle hills of more resistant siltstones, sandstones and quartzites belonging variously to the same Silurian rock formation, to the underlying Tallong Beds and to the overlying Devonian rocks.

Combine this recessiveness in the general relief with the impounded nature of the karsts and with the nature of the precipitation and the result is that these patches of limestone are subject to extremely variable amounts of water and erosional attack, both chemical and mechanical.

A fifth generality which we have to bear in mind constantly is that in all these areas an essential characteristic of the geomorphology is the rejuvenation of the drainage by tectonic uplift of the plateaus in which these tiny bits of limestone are set. The incidence of river incision is crucial. Its effects are most striking at Bungonia and least at Wee Jasper where the river has cut only a little below the limestone. At Yarrangobilly the limestone forms a broad and high shelf or strath on one side of the valley; this was the former valley floor but a gorge has been carved more or less along the western side of the limestone. The basins at Cooleman and Wombeyan differ somewhat in that a strikingly planate surface of erosion in the limestone largely survives at Cooleman though encroached upon by gorges whereas the Wombeyan marble was reduced to hilly relief before gorges developed through later rejuvenation. There are indications that it was similarly an enclosed plain in the past.

Active tectonic movements may be involved in speleogenesis in places like New Guinea, even creating voids and certainly affecting the development of erosional voids. In southeastern Australia the earth's crust has been much more stable for a long time. Some faulting has taken place in the Tertiary and shifts may still be taking place along faults such as the Berridale Wrench Fault and the Jindabyne Thrust Fault (White and others 1976). The Lake George Fault appears to have been reactivated in the Tertiary, though recent work (Coventry 1976) proves there has been no movement in the last 20,000 years. As yet no faults have been demonstrated to have been active in young geological times in the karst areas around Canberra and the most we should attribute to this factor is that earthquakes may act as triggers to rockfall from roofs and walls of caves when solution along joints and bedding planes has already prepared blocks of rock for detachment by gravity. But, of course, the structures of the rock inherited from earlier earth movements exert great influence much later on the course of active agents of cave formation. An outstanding local case is Narrangullen Cave. A small body of Middle Devonian Limestone survives there in a down fold due to Taberabberan (Middle Devonian) earth movements. The cave passes through this inlier of limestone along the axis of the syncline; in detail the cave switches from one side of this structural axis at the upstream end to the other at the downstream end.

It follows from the generalisations already made that the karsts around Canberra fall into the category of 'fluviokarsts' of Roglić (1960) as Sweeting (1972) has already recognised. Fluvial processes are as important as distinctively karst processes. Surface river valleys, especially gorges, dominate the landscape; streamsinks, blind valleys and dry valleys are usually more important than dolines. One character frequently found in fluviokarsts does not apply however. The rivers do not cut down through the karst rock and compartment it into blocks with impervious basement between. Instead the carbonate rock reaches deep below the lowest associated drainage lines.

SOME ELEMENTS OF SPELEOGENETIC THEORY

Let us turn now to some basic considerations of theory regarding the development of karst caves which are relevant to our local caving areas.

Solution is the prime process, though it is true that for a long time there has been neglect of the mechanical aspect of water erosion in caves. Newson and Smith's quantitative work in the Mendip Hills of England has shown this to be a greater factor than has latterly been overtly recognised. Though in total removal of material, mechanical erosion remains subordinate to chemical erosion in the Mendip, (Newson 1971, Smith and Newson 1974), they tend to operate at different times and places within the system. The importance of the mechanical aspect with regard to caves is undeniable and we must remember that in Mendip there are only small inliers of non-karst rocks to supply durable tools to the cave streams whereas, as mentioned already, in our karsts much larger supplies are available to our caves surrounded as they are by other than carbonate rocks. So it is the hydrodynamic circumstances in which solution, and in certain phases mechanical erosion, operates underground that primarily concerns speleogenetic theory.

What are these contexts or at least those which are relevant to understanding the caves around Canberra (we can, for example, neglect the artesian context)? I would like to present them under my own array of names, selected and invented, which will justify themselves or be justified below. They are the contexts of (a) vadose seepage, (b) vadose flow, (c) the nothephreas and (d) the dynamic phreas. Initially let us consider them through simple cases.

Vadose Seepage

In practically everyone of our caving areas we find numerous simple shafts or rifts leading down from the surface more or less vertically. They commonly express strong structural guidance, joints and joint intersections usually, but it can be bedding where the rocks are on their side as, for instance, in Jap's Hole on Punchbowl Hill at Wee Jasper. Igneous dykes may encourage their development as for instance in an example at Wombeyan. They may open from level or sloping planar surfaces, from hollows or even from gentle convexities. I have previously used the Putrid Pit at Bungonia as a local prototype; it illustrates very well how a series of pitches succeed one another downwards, not quite precisely above one another, in different joints. Their walls may be vertically scored by long grooves with sharp ribs between (Höhlenwandkarren).

They are commonly wider and longer than solution flutes (Rillenkarren) on surface outcrops.

These shafts are usually the result of solution by rainwater or soil water seeping downwards through the rock under gravity in a zone where voids are only intermittently or partially filled with water. They may narrow downwards, remain more or less uniform in plan or widen downwards, ending in a blockage of rock fragments, clay, earth or other debris more commonly than in bedrock closure.

As it is known that this vadose seepage often reaches saturation levels for calcite solution at shallow depths, downward closure of the bedrock walls is the easiest form to understand as regards process. The other modes may be due to organic matter in the seepage water, which may generate carbon dioxide biologically during descent to maintain or even enhance aggressiveness towards calcite (Jennings and others, in press). Both these explanations imply development from the top downwards. However, it may be that vadose seepage shafts often develop from below upwards, water percolating through planes of weakness for some distance before the process of solutional widening begins. If solution begins below and extends upwards, then greater length of time for solution below could produce forms widening downwards.

Of relevance to this view are blind shafts, which extend upwards from caves but do not reach the surface. Sometimes these features are known to reach nearly to the surface; indeed open shafts often have blind shafts in close conjunction. Some former blind shafts have certainly punched through to the surface, no doubt with a certain amount of help from collapse of blocks, partially detached by solution.

The finest blind shaft near to Canberra is undoubtedly the Gunbarrel in Wyanbene Cave, 105 m high and beautifully ornamented by Höhlenwandkarren. It is, however, a special case since it reaches through the Silurian limestone, which walls it, to overlying, unconformable Devonian conglomerate. When I discussed the Gunbarrel previously (Jennings 1967a), this circumstance was not known for certain, though neighbouring blind shafts in the cave were proven to do this. However, N. Anderson searched more vigorously than we had done before and found a cobble of unmistakeable purple Devonian conglomerate beneath the shower bath that prevails in the Gunbarrel. Burke & Bird (1966) regard diffuse input of aggressive acidic water from overlying jointed sandstone into the Carboniferous Limestone of South Wales as highly conducive to the formation of blind shafts by vadose seepage waters.

Vadose Flow

The cave context where cause and effect are most obviously related is that where a stream similar to a surface stream with an air space above is rushing through a cave, descending under the force of gravity, over rapids and even waterfalls, equipped with sand and gravel. If we compare, for instance, the gorge of Mares Forest Creek at Wombeyan with Creek Cave through which Wombeyan Creek penetrates some 250 m of marble, we find many features in common because the same processes are operating in the same way.

All the mechanical actions of a river are obvious, especially in flood time, and also the invisible action of solution, for which chemical measurements may often be necessary as proof, is evident from scallops or current markings. Circular depressions in the bed, a result of rotary motion, are here a product of solution as well as of abrasion and so to my mind are best called swirlholes, rather than rock mills and certainly in preference to potholes (a most confusing term in the speleological world). Plunge pools at the bottom of waterfalls can be regarded as special cases of swirlholes. Rounded channels and chutes in the stream bed along the line of flow and asymmetrical horns between swirlholes are other characteristic features.

Underground streams tend to meander as do those on the surface so winding passages develop with meander niches in the walls where lateral erosion accompanying channel deepening leaves a succession of curving bevels like an inverted arena. Similarly the equivalents of meander spurs or cusps may be left in the roof. However without such sideways swinging, a free surface stream often makes a series of semi-circular recesses along the walls one above the other, which can be called channel incuts. If deepening proceeds much faster than lateral solution, a canyon may be produced, sometimes meandering though it may not always escape straightening by structural control, but usually leaving some signs of former streambed levels which have been occupied at different stages in its formation. Scraps of fluvial sediment left in niches and incuts should not deceive us into assuming a stage of drastic filling of the cave.

Vadose flow for us in Canberra with only small areas of limestone is prevailingly associated with streams from the surrounding rocks disappearing underground. A typical case is Cormorant Cave in the Goodradigbee valley near Cooleman Plain; a small stream comes off the steep granite slope of Jackson and enters a cave almost as soon as it encounters the limestone through which it falls in a rather direct vadose passage to the Goodradigbee. However vadose streams can gather together from seepage water and be quite independent of streamsinks. Originally diffuse flow in the limestone becomes concentrated. Lack of large areas of karst near Canberra militates against clear cases of this kind though the process contributes to all our underground streams. However the stream in Wyanbene Cave falls into this category. No streamsinks have been found on the limestone outcrop or on the cap of Devonian conglomerate and sandstone on the ridge behind so it must simply be a gathering of seepage from above, exemplified in the shower of drops that one experiences in the Gunbarrel already mentioned.

Seepage waters rapidly become much richer in calcium and bicarbonate ions than streamsink water does. We are familiar with seepage waters forming stalactites and other speleothems, even stalagmites, in active vadose stream passages, though of course this goes on more freely, with less liability to removal, in passages abandoned by stream flow. A corollary should be that rimstone dams are more likely along a vadose stream channel fed by seepage water than one fed by streamsink water. This is not well evidenced in Wyanbene Cave. Base flow in Black Range Cave at Cooleman Plain is also a collection of seepage water, though it is possible that this is supplemented after heavy rain by some overland flow entering its entrance doline. Where flow is first met in this cave, there is a good development of flowstone floor and small rimstone dams. Farther in, however, there is a normal streambed so additional water forming the stream may be less rich in solutes.

This contrast between vadose flow derived from sinking surface streams and from seepage is relevant to the outstanding hydrogeological problem at Wombeyan. None of several water tracing exercises there has yet revealed the source of the stream in the Bouverie-Bullio-Mares Forest Creek Caves system (James, and others, in press). This aligned system heads in the direction of Wollondilly Cave and the geomorphology suggests that some Wombeyan Creek water is diverted into the right bank of its valley, though most goes into the Fig Tree-Junction Caves system in the left bank. Nevertheless no such connection has yet been proven. There is more rimstone dam development in Bullio Cave than in other active river caves at Wombeyan and the calcium and bicarbonate content of Mares Forest Creek Cave water is much higher than that of Junction Cave, though both are depositing tufa where they emerge. Nevertheless this content is not significantly greater than those of W 47 Spring and some other springs in Wombeyan Creek gorge known to have streamsink water feeding them. Moreover the problematic underground stream seems to have too much water for the area of seepage supply (likely on topographic and geological grounds) to be adequate

(Jennings and others, in press). The answer may be that it has a larger proportion of seepage water than other underground streams yet it is also fed by a streamsink supply which has still to be identified.

Vadose flow caves are characteristically dendritic in pattern, that is one stream passage joins another to form a larger one like branches of a tree ultimately fusing to form a trunk. Again the small size of our karsts militates against much development of this kind, the simple case cited of Cormorant Cave being typical around Canberra. There is a short confluent tributary stream passage in Barber Cave, Cooleman Plain, but it is likely that this is only another line of entry of the stream which flows into the Wet Entrance of the cave from Black Mountain. When in rare occasions in flood time Murray Cave (Cooleman Plain) functions, it receives a tributary along the branch to the north, probably of seepage origin. But Murray Cave is going out of action as a stream caye and eyen this is not a very good example. We know, of course, of separate vadose inflow caves feeding the same spring, e.g. the drainage systems of Coppermine Cave and Hollins Cave at Yarrangobilly; nevertheless dendritic patterns of active vadose passages have not yet been explored there.

The Nothephreas

A turbulent underground stream with airspace above cannot form a cave, it can only enlarge what has been produced in some other way, though it may be only a small thoroughfare penetrating the rock which it inherits. The chance that tectonic activity or erosional offloading or gravitational slip has not only created a connected chain of voids large enough for such flow but created them where one end can collect a surface stream and lead it down to another lower end where it can be disgorged is rare. Therefore most of the caves we are concerned about almost inevitably start from tiny tubes and half-tubes that have been dissolved by water saturating the rock mass and developing minuscule threads of flow which take advantage of any planes and other loci of weakness, including such initial voids as there may be. These tiny tubes form anastomosing patterns, forking and rejoining in complex ways, not simply in single planes (though this is the manner we see them displayed most frequently as for example in the Opera House in Fig Tree Cave, Wombeyan) but three-dimensionally.

The phreas is the name for the hydrological zone in rocks where all voids are filled with water. Although this zone takes on a very different character in compacted rocks of low intergranular porosity such as we are dealing with around Canberra from that which it possesses in deposits of sand and gravel, for example, the term is used for both. A very important characteristic common to both situations is that water does not simply move downward from a high point to a low point as in a surface channel over impervious rocks but can follow all manner of courses downward and later upwards from a high part in the phreas to a lower one.

Because of this a cave can take on a distinctive style if solution continues to go on in phreatic conditions after connected ways through have been established, but without rapid flow being established. Spongework caves develop with irregular cavities of various dimensions interconnecting to form a complex maze. Diving alone can reveal such caves in their active state and none have yet been discovered in our area in this way; the southeast of South Australia is a better hunting-ground for them. However they may survive in large measure to be still recognisable after being emptied of their water and becoming inactive. Much of Basin Cave at Wombeyan is of this nature. In some of the Walli caves we have the same aspect though joint and bedding control of the pattern is much more evident there. Dip Cave at Wee Jasper has suffered so much breakdown and secondary deposition that its origins are not as clear as one might wish though its set of parallel passages strongly governed by nearly vertical bedding bears no obvious relationship to relief and drainage, and seems to be dominantly due to slow phreatic solution (Jennings 1963). Spongework is limited, however, and more common are symmetrical hollowings on bedding planesurfaces indicative of eddying flow but no substantial current.

Caves of this type, the phreatic caves of W.M. Davis and J. Harlen Bretz, have latterly tended to be called deep phreatic or true phreatic caves to distinguish them from shallow phreatic caves to be discussed next. However any phreatic cave is truly phreatic if we have not misinterpreted their development in a water-filled state. Nor do caves of this type require very deep circulation. In some circumstances they can form close to the surface and within a narrow vertical zone as, for instance caves such as Easter Cave near Augusta, W.A. in Quaternary aeolian calcarenites, which are dominantly spongework caves. Therefore I suggest the terms 'nothephreas' and 'nothephreatic flow' for this context, "nothes" being the Greek for 'sluggish' or 'torpid'.

The Dynamic Phreas

If there is an appreciable head of water tending to drive water through a developing phreatic system at some speed from higher to lower levels, there is a strong tendency for a few routes, indeed ultimately a single route, to grow at the expense of others. As a tube gets larger, the effect of frictional drag on its surfaces becomes proportionately less, so the speed of flow increases and the mass transfer of solutes from the rock-water interface proceeds faster also. There is positive feedback in the system.

In these conditions, pressure conduits develop of circular or elliptical cross-section, with solution attacking all surfaces. If the ellipse is disposed horizontally, there may or may not be structural control; if it is vertical or inclined, such control is operative. Because of hydrostatic head, pressure conduits can rise and fall along their length and such loops in long profile are likely to be structurally controlled. A common arrangement as Ford (1971) stressed some time ago from Mendip examples is for conduits to descend in dipping bedding planes and rise in chimneys in joint planes. Ford and Ewers (in press) distinguish between 'bathyphreatic' and 'multiple loop' caves. In 'bathyphreatic' caves, the pressure conduit describes one big downward loop to considerable depth, though this may be complex in detail; in 'multiple loop' caves, there are many down and up loops reaching to a common level, the rest level of water in the cave system or the watertable of general hydrological literature.

Dynamic phreatic action of these types is even more difficult of exploration in the active state than the nothephreatic state just described and once again no local instances can be provided. Even relict, abandoned systems of this type have eluded us for the most part. The best instance seems to be in Odyssey Cave at Bungonia where James and Montgomery (in press) have demonstrated with the aid of current markings a former phreatic loop of 45 m amplitude, now eliminated by a horizontal shortcut of the stream which formerly fashioned it. It is interesting to note, however, that this dynamic phreatic loop has as great a depth as any that can be demonstrated in our area for nothephreatic action, once again indicating that we should avoid the adjective 'deep' for the latter.

The mention of current markings in this connection is salutary because some speleologists have tended to associate scallops with vadose flow. Ceiling scallops are commonly observed in pressure conduits, demonstrating that this restriction is false. Likewise mechanical action is not restricted to vadose passages. Sand and gravel can in fact do a great deal of work in pressure conduits.

Known phreatic lift in the Canberra area is usually much smaller than the example cited from Odyssey Cave, and is typified by the 6.5 m amplitude of the inverted siphon of the first watertrap in Murray Cave, Cooleman Plain, still intermittently in action (Jennings and others 1969). This is in keeping with the fact that in our area the dynamic phreatic action we have commonly to deal with is what has been called that of the water table stream by Swinnerton, epiphreatic by Glennie and shallow phreatic by Davis. With this there is development of a more or less horizontal pressure conduit at or close below the level of the spring which it feeds. In the absence of structural conditions forcing downward loops in the phreatic circulation, action concentrates at the top of the phreas. Here the shortest route can develop with dynamic advantage. There are many abandoned examples in our area to some of which I shall need to refer later and there is good reason to think that active examples as yet unexplored link such points as Eagles Next Cave and Hollins Cave at Yarrangobilly and Odyssey Cave and The Efflux at Bungonia. These links are at the bottom of the deepest cave systems in the Australian mainland so we must take care to make sure we are not misunderstood if we refer to shallow phreatic action in their connection; 'shallow' refers to the narrow amplitude of the dynamic phreatic action involved.

Cave Breakdown and Offloading

Another process in cave development - cave breakdown - has been referred to already but it needs further comment. The inward fall of blocks from cave roof and walls cannot by itself enlarge a cave because the fallen material occupies a substantially larger volume than the space it previously took up. For a cave to be stoped upwards by this process there has to be progressive removal of material from below, mainly of course by solution though there is also some traction of material along a cave stream.

It has been proposed that a favourable circumstance for cave breakdown is when a cave ceases to be waterfilled, e.g. when phreatic conditions are replaced by vadose ones. This is no doubt so but there is plenty of evidence from the successive incorporation of speleothems into rockpiles that it can be a protracted process persisting long after such draining of a cave. A vadose stream undercuts walls to this effect. Additionally, Renault (1970), amongst others, has stressed the importance of residual stresses in the body of the rock which will tend to be released by movement of rock into the voids created by erosional processes. Again there is positive feedback in this effect, the enlargement of the cavity makes more breakdown possible than before as long as material is removed for its accommodation.

A related point of Renault's is that offloading through loss of material from valley walls, mainly by solution, can cause sheeting joints more or less parallel to the valleyside, which promotes cave formation in such locations. This needs to be considered with regard to some of our caves such as Cooleman-Right Cooleman Cave and Wyanbene Cave. Some means of testing this idea needs devising because both of these linear caves paralleling a neighbouring valley also run along the strike.

The locations of pronounced breakdown within cave systems also call for explanation. At Yarrangobilly, for instance, big rockpiles are encountered shortly after entry into several of the more important inflow or streamsink caves such as East Deep Creek Cave. Is it simply that the sinking streams are most effective in their erosional action here, and bring about most collapse by undermining?

COMBINATION IN TIME AND SPACE

In the past the tendency was to lay stress on one or other hydrodynamic context as favourable to cave formation and the result was controversy in which one such context was set against another as the locus of cave genesis. I have long thought that these attitudes were mistaken. In the Speleo Handbook published in January 1968 (but my contribution to that much delayed book was last revised in 1965), I wrote about cave theories "that each of the mechanisms envisaged does operate and that nearly all caves are composite in origin. The problem is to determine the relative importance of each kind of action in producing the present form and pattern of each cave system". In recent years monogenetic approaches have been attacked; for instance, White (1969) and Ford (1971) have each in reaction identified a variety of modes of cave evolution applicable to different circumstances. Relying mainly on his knowledge of karst areas in central and eastern United States, White based his types on overall geological structure. Ford (1971) and Ford and Ewers (in press) ranged more widely in N. America from N. Canada to Mexico and to Britain for their examples; their scheme depends on a wider range of factors. It will be useful to relate our caves to their findings.

Meander and In-and-Out Caves, and Natural Bridges

First let me make the point that simple cases are much rarer than my efforts to cite examples to illustrate the main hydrodynamic contexts would suggest. This can be illustrated by reference to the small caves closely associated with the rivers which dominate our fluviokarsts. Meander caves such as are found at a number of points along the Yarrangobilly River constitute one of the few types of cave which are perfectly plain and straightforward. Even then Verandah Cave at Borenore (Jennings 1970a) is a double-decker due to the river cutting down more rapidly for a time or swinging away from that river flank for a while.

Short in-and-out caves are also common along our rivers, though they can vary very much within a single area. Thus at Cooleman Plain in its northern part, only shallow valleys a few metres deep occur and here only two caves are known similar to one another where a stream has branched through a low, horizontal passage across a slight bend in a valley side. There is a sand and gravel bed and normally air space through most if not all of it. The rocks are dipping and there is no joint control in long or cross-section, though there may be some in plan. Most enlargement will take place during flood when they will be full of water. They are short watertable stream caves. Anabranch Cave (Montgomery 1971) though fulfilling a similar function is very different in character. It takes a substantial part of the flow of the Goodradigbee River in its deep valley below the junction of Cave Creek in almost a straight line through a steep spur end. It mainly consists of a tall oblique passage in a bedding plane like a tilted canal tunnel, though it has a watertrap near its upstream end. It may be objected that Anabranch Cave is not in Cooleman Plain proper. However the cave in the right bank of Cave Creek at the Blue Waterholes has similar tall fissure passages. It does belong to Cooleman Plain but to that part of it where gorges have been cut into it.

Many natural bridges are formed where rivers breach meander spurs. From a single early visit to London Bridge on Burra Creek, I classified it as a simple case of a karst meander cutoff (Jennings 1971). When the time came that we could get legal access to it once more, CSS mapped it in detail (Jennings and others 1976). We soon realised that it wasn't to be despatched in a single sentence speleogenetically; there were at least two complications. The lesser of these lay in the role of the alluvial fan which now largely fills the abandoned meander channel. The nature of buried soils in it indicates it belongs in the main to the Late Pleistocene when fan building seems to have been going on widely in the

Southern Tablelands because of colder climate and its geomorphic effects (Coventry and Walker, in press). The role of the fan may therefore have been a dynamic, not simply a passive one. After part of the base flow of Burra Creek started to go through London Bridge Cave, the independent tendency of the tributary to dump a lot of sediment in the meander channel may have helped to round off the capture by blocking flood flows and forcing them also through the enlarging cavern in the root of the meander spur. None of the earlier cave breaches of the spur here reached completion of capture in this sense.

The second complication at London Bridge is witnessed by the longitudinal profiles of the older, inactive caves at London Bridge; Douglas Cave has a steeply dropping profile down valley and it is evident that Burra Cave formerly had a similar one. The conclusion we came to was that the only satisfactory way to explain this drop was to postulate that a waterfall or rapid, retreating up the river through erosion, was held up in the meander by a resistant greywacke found there. Whilst it was held there, caves developed, descending through the limestone of the meander spur in a manner resembling the presently active Fish and Easter Caves system on Cave Creek below Cooleman Plain.

The Natural Bridge at Yarrangobilly is also not as simple as a casual inspection might suggest. There is a good deal of Quaternary tufaceous breccia in its construction and there are indications that there may have been a surface cutoff at one stage here, which was barred by fallen blocks of bedrock and tufa building. This may have returned flow to the meander bend, which is now only followed in flood with the development of the present underground cutoff through the blocking materials. The geological structure needs mapping in detail to prove this. A collapse doline exposes part of the cutoff course beyond which the underground stream forks into a major and a minor arm. On steep slopes in the valley here, there are vegetated, fixed screes which belong to a past phase of much more active weathering of the limestone faces; once again the cold period of the Late Pleistocene in the SnowyMountains comes to mind.

Thus major themes for cave study around Canberra emerge by reference even to these very simple kinds of cave.

Alteration of Vadose and Epiphreatic Activity

The mention of waterfall retreat in connection with London Bridge leads to one of these themes, namely, the effects of rates of valley incision. Our larger caves owe much of their complexity to this as is well exemplified in the Punchbowl-Signature and Dogleg group of caves at Wee Jasper (Jennings 1964a, 1967) so well visited that I needn't go into detail. In the dry Punchbowl-Signature system we can recognise, mainly from flat solution roofs in nearly vertical beds and from remnants of elliptical tubes, four levels of epiphreatic or watertable cave development whereby a stream passed through Punchbowl Hill. In the intervals between, vadose downcutting took place. In the lowest part of the system nearest to Dogleg, spongework and related features prevail where nearly stagnant water enlarged the cave for a time whilst its former dynamic role was being taken over by Dogleg Cave, the active river cave. When the 7 m inverted siphon at the Opera House in Dogleg comes into action, much of the forward, low meandering part of the cave can fill to the roof so that it is intermittently epiphreatic in nature now. Phases of vadose flow before and after these peaks of erosional activity are separated by low stages when a lower, impenetrable route to the outflow comes into use.

This theme of alternation of different kinds of cave development through time as surface rivers cut down their valleys in or close by the limestone repeats itself through the area (e.g. at Marble Arch, Nicoll and others 1975). Epiphreatic cave development is much more common than other kinds of phreatic development. There may not be so many levels in the one cave as in the case cited. For example, Barber Cave at Cooleman Plain has only two. Both of these exhibit the dominance of vadose activity at the inflow end of this through-cave with epiphreatic activity taking on a greater role in the morphology at the outflow end. Cave enlargement seems to have been propagated from the spring end upwards in the manner envisaged by Rhoades and Sinacori (1941). Slight further incision of Cave Creek has turned the lower epiphreatic level into a vadose state.

Another arrangement is one where one epiphreatic cave is replaced by another. We can have little doubt but that there is an active epiphreatic cave behind the Blue Waterholes at Cooleman Plain similar to the abandoned one upstream now constituting the dry Cooleman-Right Cooleman Caves system some 10 m higher than it but quite detached from it (Jennings 1970b). Study of the characteristics of the various springs at the Blue Waterholes indicates that the normal flow at any rate comes from the one conduit (Jennings 1972). A short phase of increased rate of incision has here been accompanied by a sideways jump in the point of outflow but the cause of the displacement, structural or otherwise, has not been perceived as yet.

Other variants on this theme are plentiful in the area as the guide to the excursions will reveal. Let us turn to the general question as to why epiphreatic (watertable) caves as distinct from bathyphreatic or multiple loop caves are prevalent in our area. Ford and Ewers (in press) point out that for obvious reasons in steeply dipping rocks developments of the latter kind are favoured whereas gentle dips promote the former type. Our area would tend to contradict this. Another thesis of Ford's helps out, namely that if the drainage from inflow to outflow tends to be mainly along the strike, this in its turn favours horizontal development along the strike. My first example of Punchbowl-Signature and Dogleg is along the strike (though there is meandering along substantial sections). Again at Bungonia, the long Fossil Cave - Hogans Hole extension has much epiphreatic passage along the strike, whereas the big loop in Odyssey Cave occurs where the chief underground stream is descending the dip in accord with the Ford/Ewers concept.

Nevertheless many of our epiphreatic cave passages run in the sense of the dip and cross the strike, e.g. Coppermine at Yarrangobilly, as must the link between Eagles Nest and Hollins Cave there also (Pavey 1974). To help with these instances and for perhaps the overriding factor generally we must turn to another factor in the Ford/Ewers general theory, namely fissure frequency. With increasing fissure frequency in low or in steep dips, hydraulic conductivity increases also and this permits the most direct routes down the hydraulic head to develop readily. So as fissure frequency increases, the favoured sequence is from bathyphreatic through multiple loop to epiphreatic caves. There is no doubt that we are dealing in our areas with highly fissured rocks (even in the case of the Wombeyan marble) as a result of a long tectonic history, the proximity of igneous intrusion in many cases, and also the nearness to valley walls which results in offloading joints.

This stress on the various modes of dynamic phreatic action must not let us disregard the role of the nothephreas. In this respect we must cleave to White's system, for Ford and Ewers do not retain a place for it as a significant cave-forming hydrodynamic context. This latter standpoint may be justified against a canvas of large karst areas and very big cave systems. With our small karst areas it occurs sufficiently frequently to warrant it being classed as a normal case. White's diffuse flow category approximates to what I have here termed nothephreatic but his restriction of it to impure limestone and coarse dolomites does not apply in our area where the instances cannot be differentiated on this basis. Some of the caves I am inclined to place in this class appear to relate to an early and different stage in the relief development. Durins Tower Cave at Wombeyan is in the top of a knoll which is one of the highest points of the karst there (Jennings and others, in press). It probably formed when the present ridges belonged to a former basin plain. The Wellington Caves also relate to a time when the limestone there formed a valley floor instead of a low ridge (Frank 1971). Clown Cave at Cooleman antedates the gorge it overlooks. These and others correspond to the classic Davisian situation of phreatic development beneath a planation surface; subsequent rejuvenation of drainage has left them high and dry, unrelated to present relief. However not all cases are explained in this way. Basin Cave at Wombeyan is best interpreted as the result of a blind input from Mares Forest Creek, which may have developed a certain degree of throughflow initially but failed to keep pace with faster incision of the creek and eventually lost sufficient supply for even nothephreatic growth. Fred Cave still taps the river water and must be enlarging slowly still.

Rejuvenation in General

Rejuvenation of drainage and relief lies behind much of the previous discussion and it is useful now to look at this in more general terms in relation to the caves.

At Cooleman Plain there is a pronounced contrast between the slight dissection of the limestone planation surface over the northern part and round the margins of the southern part and the pronounced dissection above and below the Blue Waterholes (Jennings 1967a). Caves are insignificant in the first context; Devil Hole is probably the largest and it is only a short inflow cave for one of the largest of the many streams flowing off the igneous rim onto the karst. All caves of appreciable length and size are associated with the gorges. Circulation was promoted here, hydraulic gradients increased and probably fissure frequency also, though this may not have mattered so much as that frequency is generally high. The caves are mainly outflow caves such as Murray Cave and between-caves such as River, Frustration and New Years Caves.

Caves are more frequent and larger at Yarrangobilly because the main river runs for the most part along the side of the limestone outcrop and has cut a deeper gorge than Cave Creek; favourable conditions for cave development reach more widely and more strongly. Substantial inflow caves occur as well as outflow. At the downvalley end where the depth of incision below the old valley floor is greatest, there is a fine sequence of replacement of higher caves by lower caves functionally (Jennings 1964b). Jersey Cave, the two Glory Caves, River and Federation Caves represent a sequence of the former and present outflow caves of the sinking Rules Creek over a height range of 120 m. The shortness of the tunnel which had to be cut for the North Glory self-guided circuit indicates how near it was to becoming a through-cave at one stage. Indeed collapse may have blocked off such a cave. Jillabenan and Harrie Wood Caves are former outflow points of Mill Creek. That creek now sinks in Mill Creek Swallet whereby it flows towards River Cave to join Rules Creek in that vicinity. So Jillabenan, Harrie Wood, River and Federation Caves also form a descending sequence.

To add to the interest here Castle and Grotto Caves must also have let out Mill Creek water at certain stages so Mill Creek has had a very complex history, which should become clearer when the careful surveys now well on the way to completion are interpreted.

In all the instances so far, cave development seems to have kept pace with valley degradation or nearly so. The active outflow caves of today are either right at river level, e.g. the Blue Waterholes at Cooleman Plain and Bubbling Spring at Yarrangobilly, or nearly so, e.g. Federation, Hollins and Coppermine Caves at Yarrangobilly, and Zed Cave at Cooleman.

Along valley bottoms, even with our unreliable climate allowing rivers to dry up, there is likely to be water in planes of weakness in the rock persisting with embryonic speleogenetic preparation so there is a strong chance that fresh outflow cave development will soon accompany the downcutting of the streambed. For example Federation Cave and the lower level of River Cave soon developed to fulfil the function of the upper level of River Cave when the Yarrangobilly River put that out of action by lowering its bed. The interval is of small amplitude. Junction Cave Spring at Wombeyan has to drop down a little fall of 7 m to Wombeyan Creek; its replacement has yet to form.

Nevertheless we do find examples where the pace of incision has clearly been too great. The most notable cases near to Canberra are at Bungonia. One can follow limestone all the way up to Main Gully Springs where their waters drop very steeply about 100 m to Bungonia Creek. The Efflux, which drains most of the caves on the southern side of Bungonia Gorge by a low gradient, probably mainly waterfilled passage from Odyssey Cave, feeds Breton Creek which falls about 190 m down to Bungonia Creek. Breton Creek flows mainly over interbedded impervious rocks but there appears to be no structural impediment to the development of caves in pure limestone along the strike for water to emerge at stream level. This failure to develop has been attributed to incision too rapid for cave formation yet to have taken place in the lower levels of the limestone strike belts (Jennings and others 1972; Jennings and James (in press)). Even before this time when underground development got out of step with change in surface relief, there had been a phase of rapid incision because it is at Bungonia that vertical development in caves is most pronounced for the Canberra area with caves such as Odyssey, Drum and Grill Caves and Argyle Hole. All these have some sort of small catchment on the surface so they have vadose flow but some of the other deep shafts here rely on seepage water only for their formation as has been mentioned earlier.

The great depth of vadose caves here reflects the considerable available reliefprovided rapidly by river action. There are also more or less horizontal passages, mainly impenetrable, between the Fossil Cave - Hogans Hole Extension, the Drum, the Grill and the Odyssey Caves, and The Efflux. This suggests a halt in the downcutting of Bungonia Creek just as the flights of caves at Yarrangobilly indicate a series of such pauses. I shall return to this question later.

Co-existence of Different Speleogenetic Actions

In the previous section I have stressed the idea of one phase of cave development being succeeded by another of a different kind and so on in the evolution of the cave over time. We must always remain well aware,however, that different kinds of cave enlargement go on at the same time both in caves which are near together and within the one cave .I have already pointed out the great difference in nature between Dip Cave and the Punchbowl-Signature and Dogleg group at Wee Jasper yet they occupy much the same position in the general relief of the Goodradigbee valley and must have formed at much the same time (Jennings 1967). The same is true of Basin and Bullio-Mares Forest Creek Caves at Wombeyan (Jennings and others,in press). There also the active level of the long Fig Tree-Junction Caves system includes alternating vadose flow and epiphreatic sections along the streamway. Again this applies to the River-Murray Caves system at Cooleman Plain (Jennings 1969). As a model for interpreting cases of this kind there is an excellent account by Palmer(1972) of Onesquethaw Cave in New York

State, United States, where the detail of the geological structure can be shown to be responsible for lengthwise variety of this kind. It is true that obvious structural controls are not evident in the caves of ours I have cited but this direction of detailed geological mapping is one which badly needs pursuing more rigorously here.

Palmer also stresses the important role of floodwaters in Onesquethaw and other caves, which really masks the differentiation between vadose flow and epiphreatic. Some time ago I emphasised myself that with our caves so liable to large, rapid changes in discharges, cave rivers readily developed 3-dimensional anastomosing complexes of passages (Jennings 1967a, 1968a). A surface stream is free to braid into many channels over its flood plain thus reducing rise in stage level; passages fill to capacity in caves in flood, forcing levels up to maintain high level passages in intermittent action along with lower ones carrying base flow. Palmer (1975) calls these floodwater mazes. One of the best active ones in Australia to my knowledge is in the Honeycomb Caves at Mole Creek in Tasmania.

Palmer's work in general draws attention to local factors of various kinds within active caves, inducing areas of different hydrodynamic development from that prevailing generally within each cave. I believe this theme is particularly relevant in south-eastern Australia as a result of various of the regional characteristics I went into at the beginning. For instance, rockfalls and big inputs of allogenic gravels (which of course are especially liable to jam up at rockfalls) can bring about small sectors of phreatic action and of phreatic features in a prevailingly vadose cave, not only of epiphreatic action but also nothephreatic, as for instance in Y 10 at Yarrangobilly.

All this means that when we try to work out the evolution of a cave, we must avoid relying, if we can, on one or two scattered geomorphic features for inferring particular hydrodynamic contexts for the whole of a cave at a given stage of development. Simple situations are and have been rare.

EFFECTS OF CLIMATIC CHANGE

The impact of climatic change on cave development in our area has been touched upon already once or twice. This again is a factor which needs exploring more thoroughly than has been done so far. Pursuing this will be helped by the reconstruction from other sources of the climatic history of the area (Bowler and others 1976). Study of glacial and periglacial geomorphology and pollen analysis of organic materials in the Snowy Mountains has demonstrated the occurrence of a colder period than at present starting at a little before 30,000 B.P. and lasting till around 10,000 B.P. There probably were earlier colder periods but no positive evidence survives. Since 10,000 B.P. there hasn't been much change in temperature though it was probably a degree or two lower about 3,000-2,000 years ago.

The direct effects of lower temperatures in our caves were probably slight, though I have suggested that angular material in the Antechamber of Murray Cave, Cooleman Plain, may have been due to frost wedging reaching into that chamber at the time there were glaciers in the Snowies. However lowered temperatures resulted in reduced vegetation cover over some higher parts of the Southern and Central Tablelands and exposed soil and rock slopes to more rigorous weathering and mass movements of materials. At Wombeyan angular debris was fed by accelerated slope processes into the lowest entrance of Basin Cave (Jennings and others, in press). Another consequence was that more material was fed into the rivers and this indirectly affected caves.

But perhaps the greater impact of temperature change from our point of view was its influence on evaporation, which altered the amounts of water available for cave formation substantially. Undoubtedly there were also variations in precipitation causing direct variation in water amounts for geomorphic action. The evidence, which comes down to us whereby we can reconstruct past climates, largely reveals changes in amounts of water in rivers and lakes; it is a much harder task to determine the extent to which these changes are due to alterations in evaporation or in precipitation, in other words in effective or in absolute precipitation. For cave study, this difference could be important because the two climatic elements may have different effects on stream inflow and percolation into karst rocks. For instance evaporation may reduce input of streams from surrounding rocks more than it reduces percolation of rain falling directly into the limestone. For the Snowy Mountains, Galloway (1963) has inferred that the small size of the glaciers which formed there in the main cold period, coupled with the estimated substantial temperature drop, implies reduced precipitation at that time. Nevertheless streams in the area probably had higher peak discharges and shifted bigger loads of sediment then (Ritchie and Jennings 1955). About this time also Lake George was much larger and deeper than at present (Coventry 1976) but water balance estimations show this was due to reduced evaporation, not to increased precipitation. Singh's pollen work at Lake George (Bowler and others 1976), though in an early stage, gives a preliminary picture of paleoclimatic history back to 50,000-60,000 years during which time temperatures were varying but always lower than they have been in the last 14,000. Effective precipitation was also varying and Lake George alternated between long periods of high level and of drying out.

Little or no work has yet been done to determine what effects these changes had on the caves around Canberra. I have investigated what happened in a dry valley on Cooleman Plain (Jennings, in press). It was formerly a blind valley, in form much like that of River Cave nearby, but then it was filled up to its threshold level by a mudflow from the igneous slopes above, which nowadays do not suffer such mass movements. This behaviour can be related to periglacial activity in the cold period of 30,000-15,000 years ago which also gave rise to periglacial blockstreams elsewhere on the plain. This fill blocked up the cave which must formerly have taken the stream that cut down the valley to produce the threshhold. The stream, now flowing down the whole length of the valley, proceeded to sort the very mixed mudflow materials, redepositing first loose gravels, then a fine loam. Eventually the stream sank through superficial deposits at the head of its valley over the limestone. Close by, the South Branch of Cave Creek has buried with coarse gravels its main sink into the limestone; base flow still sinks here though at a higher level than previously and this may have increased the likelihood of flood flow travelling farther on into Ev's Cave, the overflow streamsink. Goede (1973) has described similar happenings in the Junee karst in Tasmania and I have described the filling of caves at Mole Creek with outwash gravels from the ice-capped Lakes Plateau there (Jennings 1967). Such developments as these have drastic effects on developing cave systems, rerouting water flow significantly.

There was probably also the tendency to develop new caves through new points of input and augmentation of that input, i.e. there was the development of 'invasion' vadose caves (Malott 1937) as distinct from the normal 'drawdown' vadose caves such as we have already described (Ford and Ewers. in press). Marjorie Sweeting and I pointed to the peripheral channels along the sides glaciofluvial and periglacial fluvial fans below the Great Western Tiers, which pumped water into the limestone alongside (Jennings and Sweeting 1959). Goede

(1969) considers part of Exit Cave to be of similar origin. So we appear to have had contradictory effects in cold periods, filling and blocking some cave passages, opening up new ones. Permafrost which would have prevented the latter event was apparently absent from both the southeastern mainland and Tasmania. I do not know Jenolan Caves well but what I have seen leads me to think that both excavational and depositional effects of cold periods in the Pleistocene are involved significantly in the development of caves such as Mammoth.

It will have been evident from the preceding discussion that study of cave sediments is the main key to elucidating such climatic effects on cave development. The most detailed work on cave sediments so far in Australia has been that of Frank in the western Central Tablelands a little beyond our ambit. Some climatic history conclusions were derived from the cave sediments (Frank 1975) but perhaps of more direct relevance to the present theme is part of the story he established for Tunnel Cave at Borenore where a dry period around 28,000 B.P. permitted flowstone and dripstone to build right across a stream passage as a result of its reduced flow. Stream flow has been restored through it in wetter conditions since.

SPELEOCHRONOLOGY

I have always found it difficult to say much about the ages of caves around Canberra; this is part of the wider problem of the general denudation chronology of the Canberra district about which most divergent views have been held. Reliable dating means were just not available and one was forced mainly to proceed by dint of rather speculative inferences. Many of the methods for speleochronology set out by Ollier (1966) either have not been applied or were not applicable in our area. The situation is improving but there is a long way to go as I shall illustrate in outline.

The host rocks are very ancient and their age has little relevance for cave dating here since the voids in them were created very much later. Generally the area has been a land surface since before Permian time (c.280 million years) though the eastern margin including Bungonia was under the sea for a time within the Permian. Again this upper limit is well beyond the times we are concerned about.

Dateable materials within the caves set minimum age limits for the spaces they partially fill but sometimes the cave geomorphology shows some chambers or passages to be younger than the dated deposits. Radiocarbon dating of charcoal and other plant material, animal bone and even bat guano in flowstone, as well as of flowstone itself, has been the chief absolute or physical dating method employed so far in Australian caves, unfortunately not yet within our area. It will be useful nevertheless to refer briefly to Frank's work on cave sediments from the western Central Tablelands by way of illustration. In the last 30,000 years, deposition has been the rule in Douglas Cave at Stuart Town, though one entrance has become blocked by this fill and another small entrance has opened (Frank 1969). Wellington Caves appear completely to antedate extensive fills, much of them mined out for phosphate; the sediments range back to 40,000 to 50,000 B.P. (Frank 1971). The Walli Caves failed to yield dateable material but the interesting sequence of sediments is effectively subsequent to the formation of the caves (Frank 1974). At Borenore two new cutoff passages have developed since sediments dated at 27,000 B.P. accumulated in an earlier one and Tunnel Cave was extended significantly headwards to a new entrance and its passages were deepened since 28,000 B.P. (Frank 1972, 1973). In both cases, however, the earlier phases of their development go back much further in time than the dated sediments.

Animal bone and human artefact assemblies from caves have been rendered useful as means of dating now that many sequences of cave deposits containing them have been radiocarbon-dated. It now appears that all extinct species belong to the Pleistocene so that deposits with such bones and so the containing caves are at least about 14,000 to 15,000 years old. A case in point is (or rather was) a cave at Wombeyan, practically sediment-filled and exposed in quarrying there, which included the bones of several extinct species (Hope, in press).

As already mentioned, some superficial deposits at Cooleman Plain can be attributed by correlation, not by dating, to the last Pleistocene cold period established in the Snowy Mountains. They permit other inferences. For example, Barber Cave has two levels low down in Clarke Gorge which has a periglacial blockstream not far away, reaching down to about 15 m from its bottom (Jennings 1968b). It is likely that at least the upper level of Barber's had formed before this time. At Cooleman also, River Cave entrance lies in a dry valley with a threshold and with coarse aggradation deposits farther up which make it resemble the neighbouring dry valley with its threshold buried by a mudflow probably emplaced in a periglacial environment. Thus one infers that the tributary passage of River Cave leading down the main river passage is likely to be older than the last Pleistocene cold period also (Jennings 1969). Murray Cave, Cooleman Plain, exhibits three phases of development in its forward part (Jennings 1966). The middle appears to be related to a coarse aggradation terrace in the valley outside, again referable to colder conditions and the third phase includes at a late stage the frost-wedged gravels in the Antechamber. So it appears the two later phases of Murray Cave probably belong to the Late Pleistocene. It is evident, however, from these examples that certainty and precision are rapidly diminishing when compared with Frank's results where cave deposits were dated.

In the future, however, we can expect a firmer basis farther back into cave history when uranium/thorium dating of speleothems, particularly in conjunction with oxygen paleotemperatures, comes into use in southeastern Australia. This has proved itself in N. America and New Zealand already. I understand results of this kind will soon be forthcoming from Tasmania. A preliminary experiment with a speleothem from Murray Cave, Cooleman, shows there are suitable materials for this kind of attack there.

Much of our cave history will, however, go back beyond the 300,000 year range of uranium/thorium dating and then things get much more difficult. For example, when writing about the age of the Wee Jasper Caves, I could only be very vague (Jennings 1963, 1964). They formed subsequently to the time when a valley bench about 60-70 m above the present level of the Goodradigbee formed the valley floor. This valley bench is some 300 m below nearby plateau surfaces which carry basalt remnants only ascribable to the Tertiary as a whole at the time I wrote. Since then, potassium-argon dating of basalts has been done throughout NSW and different lava provinces recognised (Wellman & McDougall 1974). The ones to which I have referred belong to the Snowy River province dated 22-18 million years. It seems fairly sure that the Goodradigbee valley was deepened very substantially after this so we can say that the Wee Jasper caves are much younger than these lavas.

Similar dating of Tertiary basalts near Cooleman Plain helps put an upper limit on all cave development there. Basalts capping hilltops in the Kiandra area belong to the same outpourings of lava 22-18 million years ago. The nearest basaltic hill cap to Cooleman Plain is on Peppercorn Hill some 250 m above the Long Plain, separated from Cooleman Plain by the Cooleman Mountains. The geomorphic relationships are such that we can be confident that plains

200-300 m below that residual mesa had to be eroded before the oldest caves at Cooleman Plain began to develop close to the planation surface there. But most caves relate to the incision of gorges into that surface and much more time still must have transpired before caves in the gorges such as Barber Cave developed. So we still have only very broad limits between which we must set the origins of Cooleman caves.

There are lavas on the limestone shelf at Yarrangobilly which belong to the same lava province also. This makes the relationship of the caves much closer to the lavas; they should belong more closely in time to the outpouring of the lavas. However there is a snag. Covering rocks on limestone are very liable to solution subsidence so that these lavas may have been lowered along with the limestone shelf through solution. The shelf surface may in fact be younger than the lavas. Subsidence disturbs the rocks lowered in this way so it is necessary to make sure that the lavas on the shelf are in place.

Even without the complication of solution subsidence, potassium/argon dating of Tertiary lavas may not ensure a completely straightforward cave history as Bungonia exemplifies (Jennings and others 1972 ; Jennings & James, in press; Jennings 1975). Apart from some shallow cave development of phreatic aspect close below the plateau surface, which might be ancient, the main cave development is active and dominantly vadose down to a horizontal level of active, epiphreatic nature roughly 400-500 m below the plateau. As mentioned earlier, the deep vadose shafts are thought to be a response to the earlier of two phases of valley incision for which there is similar evidence along the main river, the Shoalhaven. The later incision went on so rapidly we argued that cave development could not keep in step and hanging springs resulted. From dating of NSW basalts and their geomorphic relationships, Wellman and McDougall (1974) consider that there have been two phases of uplift of the Eastern Highlands. The second one would have set in motion the second stage of incision in the Shoalhaven valley; this would allow 10-15 million years for erosion to move inland from the coast. This interval is about 5 times longer than might have previously been considered necessary for this amount of geomorphic development. Young (1974) has argued that the great resistance to erosion of the Permian sandstones through which the lower Shoalhaven gorge had to be cut could have made this headward retreat of erosion a slow matter. At the same time Young (1970, 1974) claims that the lower Shoalhaven basin was finally uplifted to plateau level some 25-30 million years ago, even earlier than the time allowed by Wellman and McDougall. The problem is great. Nor is it resolved if we say that headward erosion moved more quickly upstream to the falls in Bungonia Gorge above the limestone than is involved in the maximum time available and then was held up at the tough toscanites in which the Bungonia falls occur. If these falls took 2 million years to retreat to their present position and have been stationary at their present position for another 8-13 million years (on Wellman and McDougall's timetable; 23-28 million years on Young's) one would have expected that not only would caves have developed to the bottom of the Bungonia limestone but there would have been considerable widening of the Bungonia Slot. The Blockup in the Slot, the product of a huge but young rockfall, is ample testimony to present widening.

If all this seems contradictory, the dating of the deep caves is even more problematic. These are considered to have developed prior to the final uplift, which set in motion the second phase of gorge deepening. On the Wellman and McDougall scheme they can be thought of as developing in their mid-Tertiary interval of tectonic stability between the two phases of uplift, but their geomorphology does not fit with such an age. Exacerbating the clash of evidence, when I presented my 1975 paper on this issue at a conference, Wellman properly pointed out a fact I had overlooked. Craft (1931) had mapped a valley filled with lava along the Endrick River valley well upstream of Bungonia along the Shoalhaven valley at a level which made it at least possible that the upper incision at Bungonia was contemporaneous with it. These basalts are Eocene in age, 45-40 million years old. If the upper part of Bungonia Gorge is as old as that, the development of the deep caves shortly after that is quite astounding in the light of their activity and youthful appearance. Dating of speleothems from their lower levels should provide some objective evidence to constrain our thinking and maybe rebuff some of our preconceptions about rates of cave evolution.

Dating our caves and determining the rates at which they are excavated is one of the great problems for the future.

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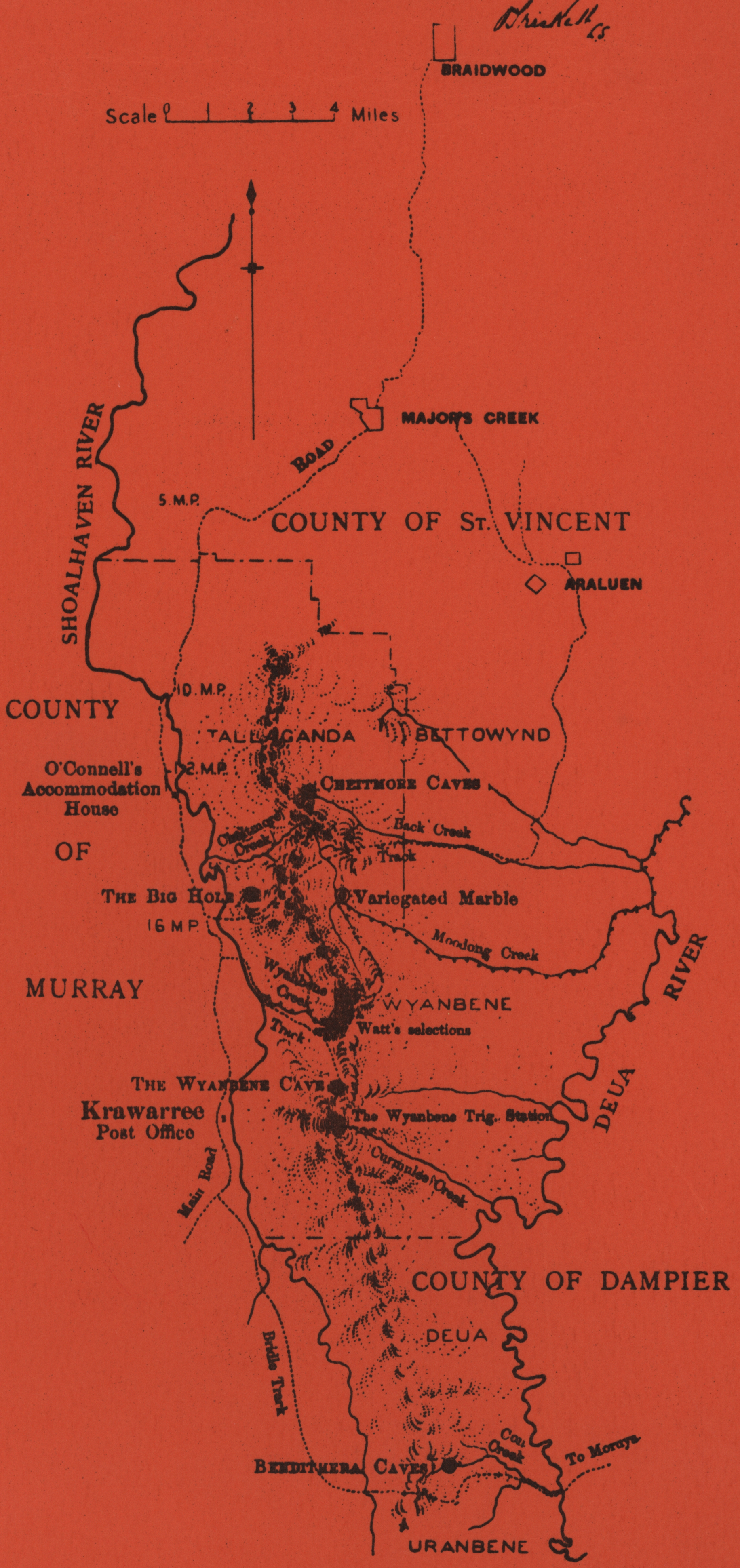
Sketch shewing the position of the WYANBENE CAVES



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