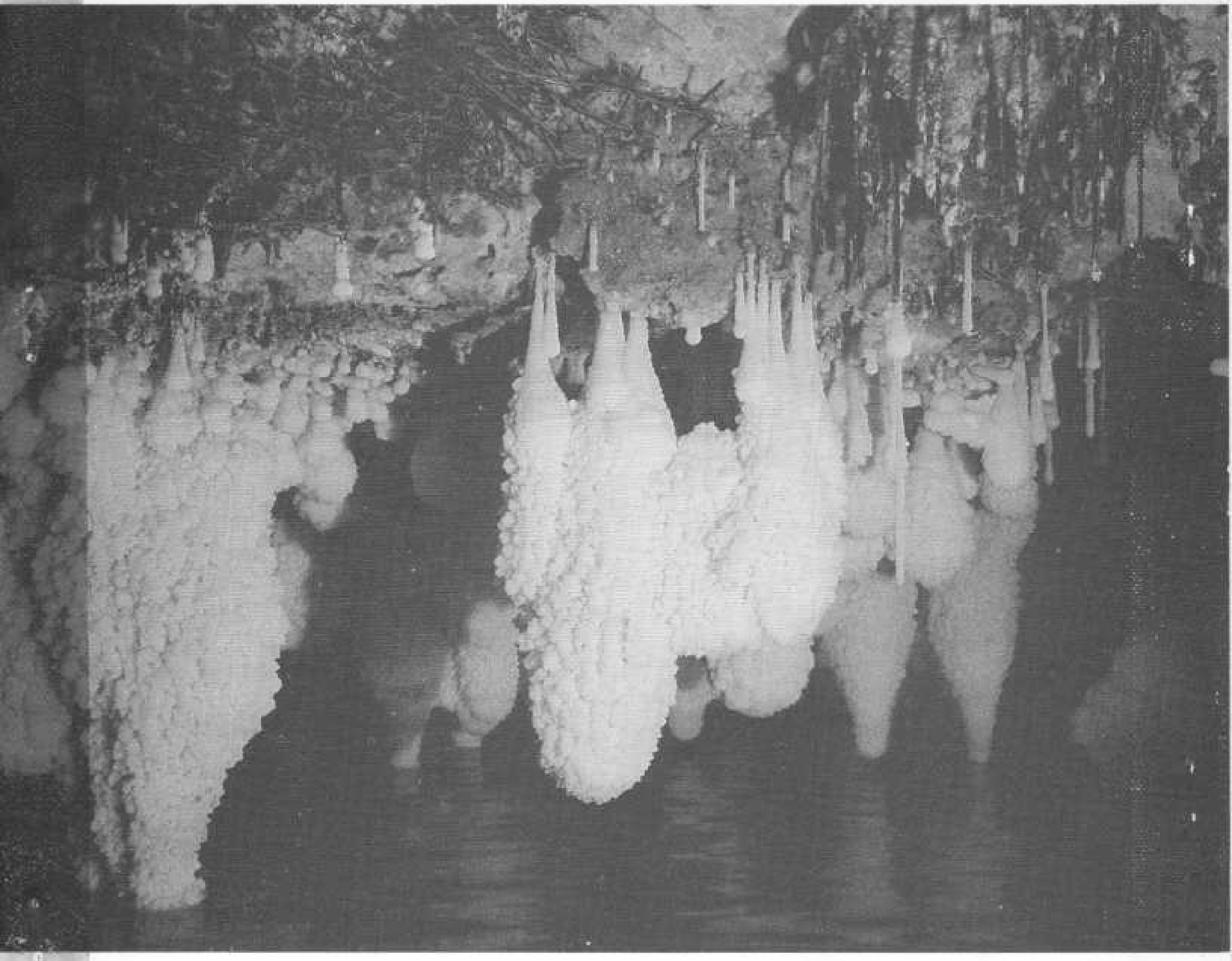
VOLUME 23 (2) 1985

Helictite

JOURNAL OF AUSTRALASIAN CAVE RESEARCH



Calcite Ram, Gondolin Extension, Easter Cave, W.A.
Photograph by Julia James

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Helictite was founded by Edward A. Lane and Aola M. Richards in 1962.

This Journal was (and is) intended to be wide ranging in scope from the scientific study of caves and their contents, to the history of caves and cave areas and the technical aspects of cave study and exploration. The territory covered is Australasia in the truest sense – Australia, New Zealand, the near Pacific Islands, New Guinea and surrounding areas, Indonesia and Borneo.

In 1974 the Speleological Research Council Limited agreed to support the Journal with financial assistance and in 1976 took over full responsibility for its production.

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To promote, support and assist in the scientific evaluation and investigation of caves and to foster speleology as a science and a sport.

To promote and to assist in the promotion of speleology and speleological Societies and to assist such Societies with grants of money and otherwise.

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PAPERS PRESENTED AT THE 15TH BIENNIAL ASF CONFERENCE

(by arrangement with the Australian Speleological Federation, Helictite is publishing the proceedings of the biennial Australian Speleological Conference. These papers are not subject to the normal Helictite refereeing process.)

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SPELEOMANIA - 15th Biennial Conference of the Australian Speleological Federation. Hobart, January 7th to 10th, 1985

PROGRAMME

Monday 7th	AM	Official Opening Bob Woolhouse - Mole Creek developments
	PM	ASF Committee Meeting, part 1 Workshop on Wilderness Medicine and Rescue
Tuesday 8th	AM	Kevin Kiernan - Tasmanian Karst Compton Allen - Ideas for further Tasmanian Caving Areas Andy Spate - Joe Jennings' Contribution to Karst Studies Albert Goede - To the Nullarbor with Joe
	PM	Excursion to dolerite caves on Mt. Wellington
	Evening - video tapes with introductory talks	Don Fraser - Exploration of Nettlebed and HH Ian Wood - Benua Cave and other Bougainville Caves
Wednesday 9th	AM	Brenton Knott & Norm Poulter - Australian Aquatic Cavernicolous Amphipods Ron Allum - Diving at Cocklebiddy Neil Smith - Survey techniques at Chillagoe Neil Smith - Water Tube Levelling Peter Matthews - Modular Mapping Peter Matthews - The Cave Database, an Update
	PM	Speleosports
Thursday 10th	AM	Deborah Hunter - Environmental Impact of Logging at Mole Creek Ron Allum - Cave to Surface Communications John Dunkley - Caving in Thailand Wayne Tyson - Anglo-Australian Expedition to Gunung Sewu Karst, Java
	PM	Kevin Kiernan - Cave Development at Mole Creek
	Evening - Cavepersons' Dinner	
Friday 11th	AM	ASF Committee Meeting, part 2
	PM	Depart for Field Trips

SURVEY AND MAPPING TECHNIQUES AT CHILLAGOE, NTH. QUEENSLAND

Neil I. Smith

Abstract

Some characteristics of the Chillagoe Caves in North Queensland are briefly described and a short history is given of the types of survey and mapping work performed. "Perimeter Surveys" around the karst towers are important contributions to speleology in the area. The reasons for this are discussed, and some work done in 1983 using theodolite techniques is described. A worthwhile improvement in accuracy has been achieved. Some examples of recent maps are included.

CHILLAGOE CAVE TYPES

Chillagoe in Far North Queensland is an area of seasonally arid tower karst. The limestone towers, which number in the hundreds, range in height (relative to surrounding topography) from 10m to perhaps 100m. Solutional weathering has reached such an advanced stage that their upper surfaces are an alternation of knife-edged ridges and deep grikes, most of which lead to cave systems of greater or lesser extent.

The towers are in fact so "hollow" that in cases where exploration has been reasonably thorough, the overall plan view maps of the towers show virtually no substantial limestone areas devoid of underground passage. Examples are the Queenslander Tower (CH5246), Walkunder South Tower ((CH5170) and Con Tower (CH5160). Most other towers have been explored less thoroughly than these and it is likely that they will prove equally cavernous.

The forms exhibited by the cave passages are quite diverse. One common type has a flat floor of mud infill and very high (10-40m) smooth rock walls usually becoming closer together towards the top. These passages often underly linear grikes on the surface and frequently connect with them, so that "daylight" holes are common. Such passages (and grikes) are apparently formed along the joints in the limestone and "silhouette" style cave maps of entire towers usually show a large degree of parallelism in the passage system. In many cases "false floors" of consolidated and calcified infill material remain suspended at various levels in these enlarged joints making superimposed passage systems common.

A second common occurrence is the phreatic solution tube. These types are often almost circular in cross-section, ranging in diameter from 10mm to 3m, and may be included horizontally, vertically and obliquely. Some extensive "Swiss Cheese" mazes are known. Connections between major passages and chambers and indeed between caves previously thought separate are frequently made by "pushing" the smaller types (not the 10mm ones!) and by exploring upper levels on false floors.

AIMS OF MAPPING

Given the nature of the predominant cave types, it is not a particularly satisfying exercise to draw maps of individual caves. Such maps often become out of date because new "connections" to other known caves are made so frequently. Rather, the TOWER is the logical unit for mapping, for a number of reaons:
(a) Underground connections BETWEEN towers are unknown.
(b) ACCURATE whole-tower maps can provide valuable information about where to look for possible connections between caves (e.g. where passages approach closest, or where two passages are collinear and obviously enlargements of the SAME joint).
(c) These same maps lay bare the joint structure of the limestone, a matter of some geological interest.
(d) A new cave entrance find can be readily documented by way of a grid reference on an existing tower map.
(e) Interesting features EXTERNAL to caves can be represented on whole-tower maps, for example cliffs, pinnacles, Aboriginal painting sites and roosts of the Black Flying Fox (*Pteropus alecto*).

However, towers frequently are 1 to 4km in linear dimensions and the scale of the whole-tower map usually too small to show cave passage detail. Larger scale maps are also required and it is convenient to organise these in modular or "street-directory" fashion with sheet boundaries corresponding to round-figure grid lines on the tower map. At Chillagoe the grid is of necessity based on a local datum but an effort has been made to correspond with the Australian Map Grid (AMG) as closely as possible.

HISTORY OF MAPPING IN CHILLAGOE

A few cave maps were produced by members of Sydney Speleological Society as a result of trips in 1967 and 1969. It was soon realised that to enable cave entrance occurrences to be documented in an orderly fashion, a network of permanently-marked numbered points arond the perimeter would be necessary. Cave entrances were in such profusion and natural features which could be described and recognised unambiguously were few and far between.

As a bonus, the perimeter network, if surveyed accurately, would provide the horizontal control "backbone" for an overall tower map. The closure error in a loop completely surronding the tower would provide an indication of survey accuracy. A surveyor working for the Queensland Forestry Department (which then administered the National Parks) established perimeter surveys around several towers (including Royal Arch Tower CH5158, 5159 and Spring Tower CH5255) with magnetic compass and steel band.

Chillagoe Caving Club was formed in 1973 with the inspiration of Vince Kinnear, and the first major club project was the mapping to CRG grade 5 of the Queenslander System (CH15). Surveying was in feet and inches, and a series of sectional (although not modular) maps was produced by Tom Robinson and many helpers. The first metric tower map was of Con Tower (CH5160) by the present author and others (1973), where again a compass-and-tape perimeter survey was done to establish the relative position of the three known caves in that small tower. Since that date various other cave maps have been drawn, with the appearance also of occasional magnetic-based perimeter surveys, including those of N. Smith (1978) and T. Porritt and D. Smith (1982) which employed tripod-mounted instruments.

However, the main thrust of the club's mapping program at Chillagoe has followed a "top-down" approach. An overall map at 1:50 000 has been produced showing the locations of all numbered towers, and an individual map of each tower at 1: 5 000 prepared from aerial photography. This is largely the work of Les Pearson. Each cave entrance is shown in its estimated position on the tower map and an approximation to the Australian Map Grid is superimposed. These maps (Chillagoe Caving Club,1982) provide an indispensable guide to cavers visiting the area and greatly aid in documenting new finds. During the preparation of the small-scale mapping by the club, the surveying the caves themselves has taken a secondary role.

SURVEY WORK IN 1983

In late 1983 the author spent nearly two months at Chillagoe engaged in exploration and surveying. Of chief interest was the Walkunder South Tower (CH5170) which was known to contain three caves, Uncle Ron's Cavern (CH135), September Cave (CH218) and Fireman's Pole Cave (CH234). A partial perimeter survey had been done so that relative positons of CH135 and CH218 were known reasonably well. The aims of the trip were to extend the perimeter survey to surround the tower completely, to survey in the positions of entrance tags relative to it, and to explore more thoroughly the three caves with a view to connecting them, together with the production of a modular series of maps of these caves.

In the event, all these aims were achieved, and the perimeter survey was extended to cover also the nearby towers Walkunder (CH5167) and Walkunder Central (CH5168). Several caves in these latter two towers were also mapped. With the modular system adopted any future mapping in the immediate area can readily be incorporated into the whole.

In most cave areas direct surface survey traverses are run between entrances to establish relative position. The more direct the traverse the less the accumulation of error. At Chillagoe, entrances which are quite close together may be on opposite sides of the tower, and a direct traverse impractical due to the nature of the steep and uneven terrain. By contrast, the open savannah around the towers is ideal surveying country. This is one principal reason for the use of perimeter networks. However, a complete loop around a tower may be 3 to 6km in length, and to be useful the survey techniques must be accurate. Previous perimeter networks, while useful for recording nearby entrances, are of dubious quality for cave mapping.

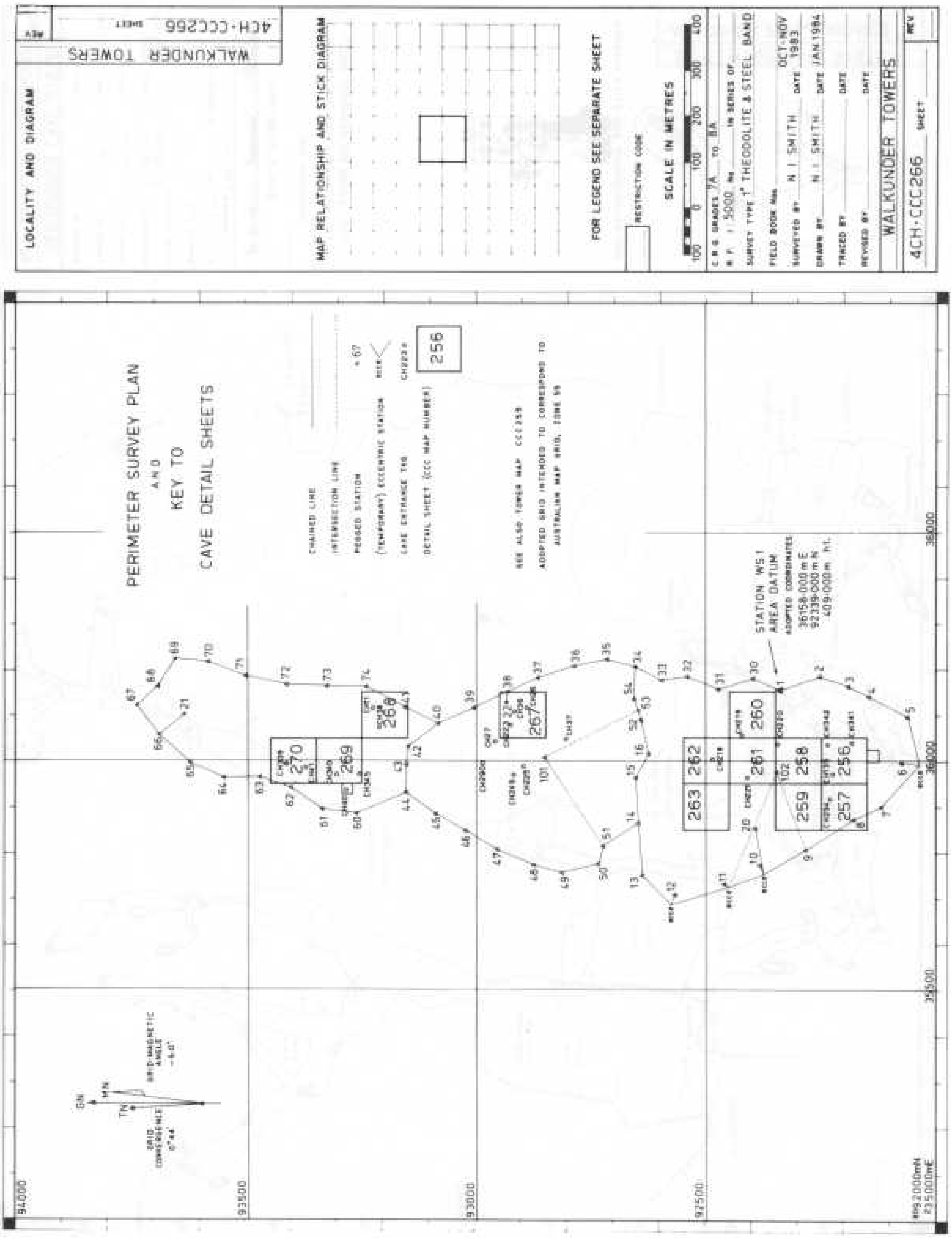

Figure 1. Perimeter survey plan.

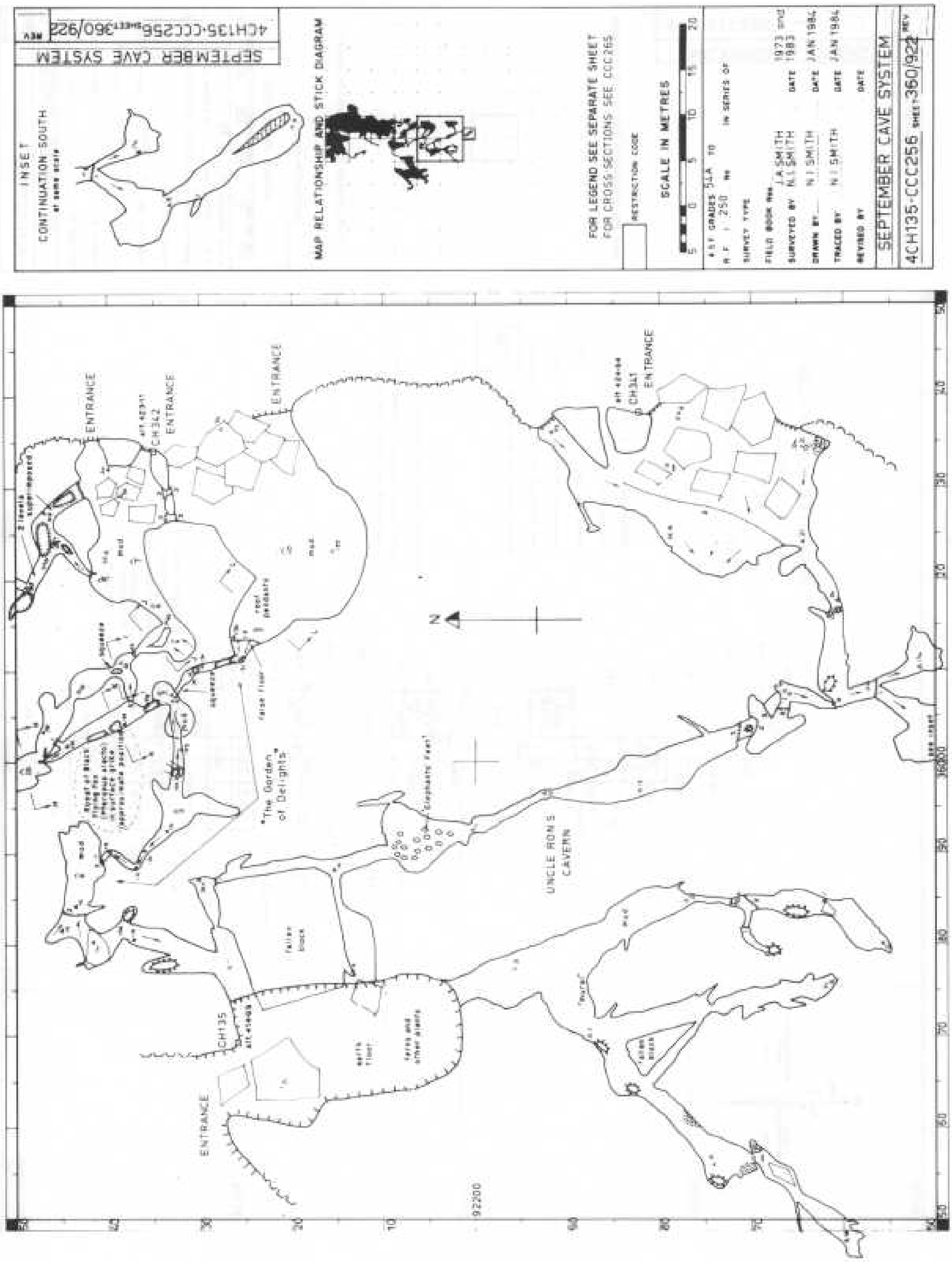

Figure 2. Example of cave detail map.

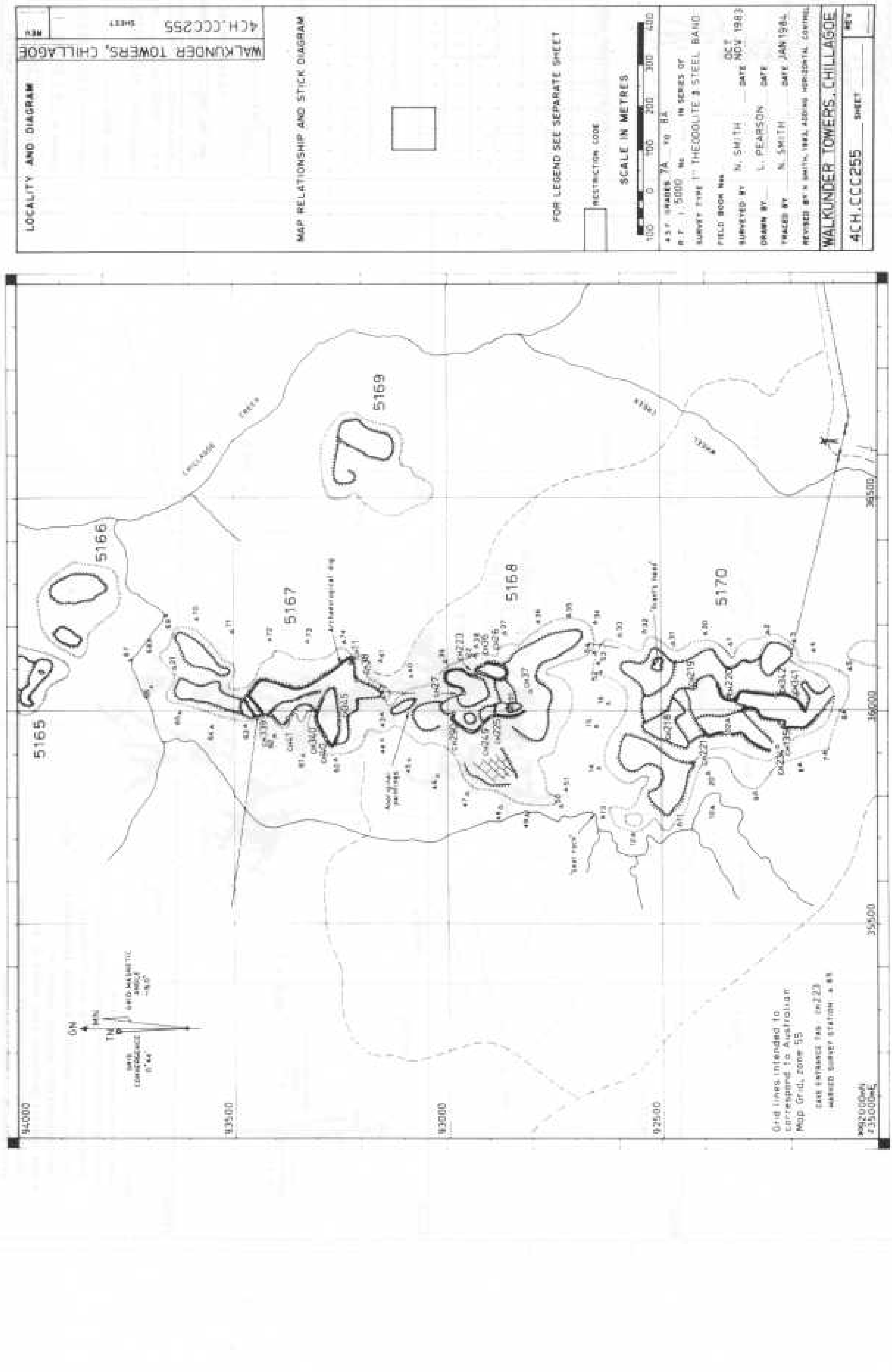

Figure 3. Tower map.

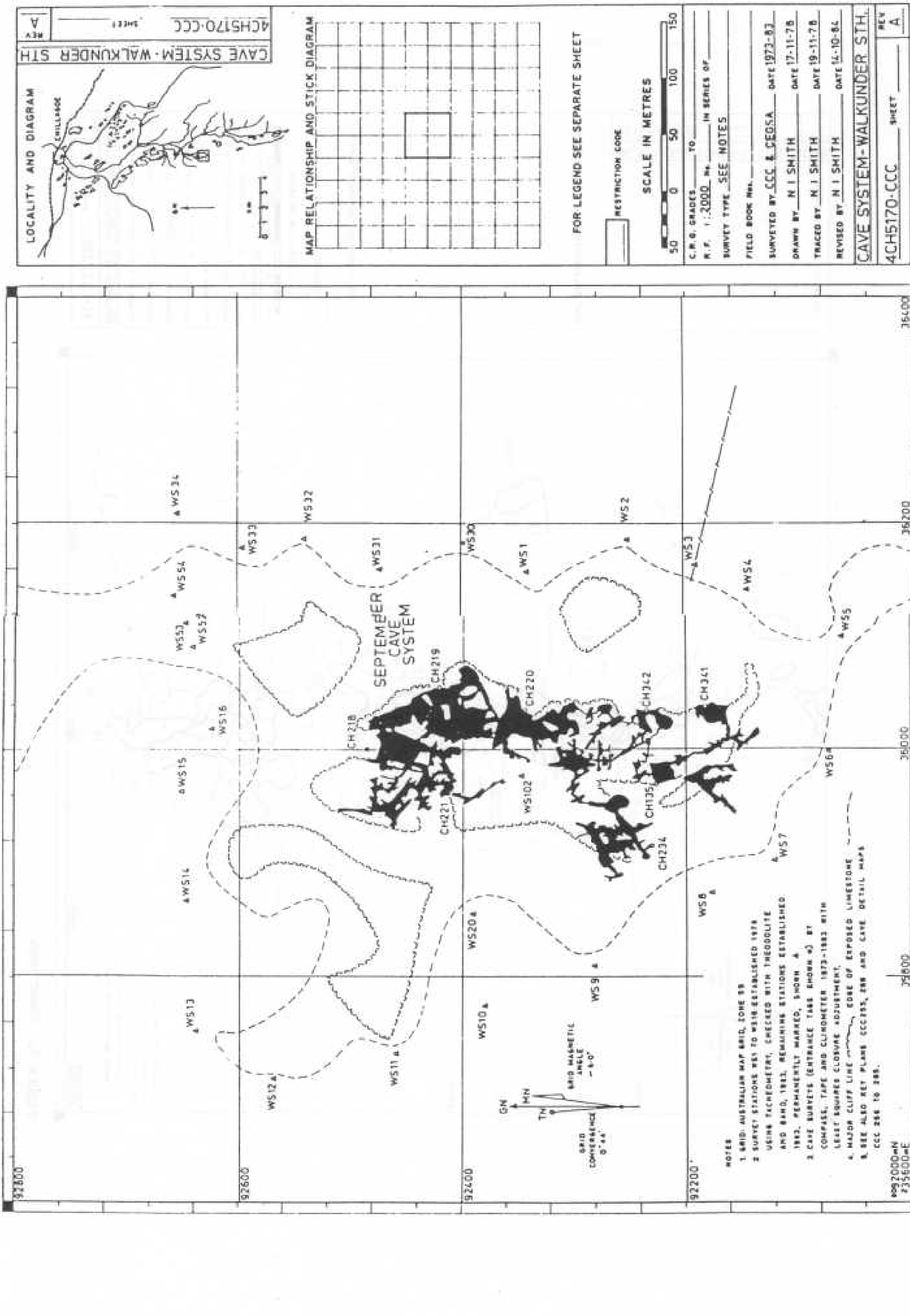

Figure 4. Cave silhouette map.

The 1983 perimeter work was performed with a Wild T2 "one second" theodolite and a 100m steel band. Sighting targets were made which could be accurately located over a station by means of a plumb bob. Using these techniques a network of 49 stations are established around the three towers, and over a total distance of about 4km a loop closure error of 300m was achieved. The three towers are separated by low vegetated limestone ridges across which surveying is practicable. Two cross-bracing traverses were run through these, with even smaller closure errors. A least-squares process (Smith,1979) was used to adjust all closures simultaneously.

All perimeter stations were monumented with yellow-painted steel stakes driven about 50cm into the ground, tags being attached to the top with wire. Relative levels of all of these stakes were also determined, by a combination of techniques. Initially, vertical angles were read on the theodolite at the same time as the horizontal traversing was done. With careful measurements also of target and instrument heights the relative station heights could be determined to about 10mm. However, this was rather time-consuming and it was later realied that a separate levelling traverse with theodolite and staff would be more accurate and quicker over the flat terrain involved. (A surveyor's automatic level would be even quicker, but we didn't have one.)

Some cave entrances (particularly those in tower CH5168) are quite remote from the perimeter and for accurate location a nearer reference point is desirable. Having the theodolite and the accurate perimater network enabled us to locate several prominent pinnacles near the centres of the towers by intersection. Heights were accurately found from measured vertical angles.

The true azimuth of the perimter survey was determined by sun shots, and knowing the grid convergence of the AMG in the region the orientation relative to the grid could be determined. However, the grid numbers themselves could not be found accurate to the 1m level since there was no marked trig. stations in the area. The best that could be done was to trace the tower outlines and grid from the Chillagoe 1:50 000 topographic map onto mm graph paper, blow this up by a factor of ten by making each mm square correspond to a 1cm square on another sheet, and then fit the perimeter survey plan around this (with the known orientation). In such a way we obtained a local approximation to the AMG, thought to be accurate to about 10m.

Surveying inside the caves, and from entrance tags to the perimeter and intersected points, was performed by conventional tape, compass and clinometer techniques. Exploration had enabled the three caves of tower CH5170 to be connected together, and the overall system (known as the September Cave System CH135) contained many interconnected survey loops, with connections to the perimeter at four points. Again, the closure errors were adjusted out by the least-squares simultaneous adjustment technique of Smith (1979).

MAPPING WORK

A variety of maps has been produced as a result of the 1983 work. Map CCC266 at 1:5000 (reproduced here in photo-reduced form as figure 1) serves as a record of the perimeter survey and also as an index to the cave detail sheets. These latter sheets are at a scale of 1:250 and each covers an area 1000m square. They are drawn on A2 size sheets (sheet copyright Cave Exploration Group (S.A.) Inc.). An example (scale reduced by 2:1) is shown as figure 2. Map CCC255 (figure 3) is an updated version of area maps CCC20 and CCC21 (Chillagoe Caving Club, 1982) to take into account the new horizontal control. Finally, figure 4 is the overall plan of the September Cave System of tower CH5170. Total surveyed passage length is 2512 metres.

ACKNOWLEDGEMENTS

Thanks are due to about twenty people inside and outside the Club who provided substantial and indispensable assistance to the 1983 survey program.

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CAVE TO SURFACE COMMUNICATIONS

Ron Allum

Abstract

The reasons for needing a cave to surface communication system are many, including safety, search and rescue, surveying, science, exploration and commentary. Ideally a unit should be lightweight, portable, robust, easy to operate, have adequate range and be able to communicate speech intelligbly in both directions.

The unit described here was designed specifically for use on the 1983 Cocklebiddy Cave expedition. When considering design parameters for a communication system there are many limitations, but in a cave as large as Cocklebiddy these can be less of a restriction.

The unit as used does not meet all the above criteria as an ideal system for all caves, but it worked well in Cocklebiddy Cave, conveying our speech intelligibly with tolerable noise and interference levels.

INTRODUCTION

The communication system to be described was designed specifically for use on the 1983 Cocklebiddy Cave expedition (Allum, 1985). The expedition involved an underground duration of 55 hours, with a base camp at Toad Hall, a large chamber 250m long, 15-20m wide, reaching about 20m above the water level. Toad Hall was the site to set up the Radio Direction Finding (RDF) or electro-magnetic location/communication device, for survey location of Toad Hall relative to the surface and as a communications post. Communication with the surface was required to aid:

1. Co-ordination of support divers to assist with the withdrawal of equipment from the cave.

2. Reassurance of and giving expedition news to the surface party, support divers and media.

3. Better utilisation of our reserve air supplies.

4. Co-ordination of rescue and first aid facilities if needed.

After considering many possible transmission methods, developmental time and facilities available, a system using RDF technology evolved. The following considerations were used to our advantage:

1. A weight of several kilos could be tolerated for the RDF/communication equipment; feather weight compared to the 1,200 kgs of diving gear taken to Toad Hall.

2. The terrain above Toad Hall is flat and relatively free from scrub, which allows for an expedient search for the transmitted signal of the RDF.

3. Both Toad Hall and the terrain above Toad Hall are suitable areas where large aerials can be located.

4. The Nullarbor is relatively free from electro magnetic interference from high voltage power distribution lines etc., allowing high gain receiver circuits to work at low frequency.

EQUIPMENT

An RDF unit (as previously described by Hurst, 1977) was used but modified to reduce transmitter battery drain. The transmitter was operated for 25 minutes 'ON' 5 minutes 'OFF'. This cycle could have been maintained for several hours whilst the search for the signal on the surface was taking place. Toad Hall lay 2.5 km to the north of the last RDF location of the first rockpile chamber.

The modified R.D.F. transmitter

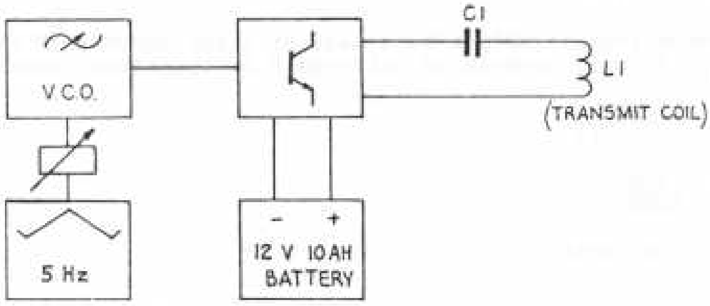

Figure 1. Block diagram of the R.D.F. tramsmitter.

Referring to Figure 1, L1 is the transmitter aerial, a coil of 260 turns of 1.6 mm dia wire on a 300 mm I.D. former. L1 in series with C1 is tuned to a resonant frequency of approx 1.8KHz , by changing the frequency of the oscillator. Current drain from batteries at fR is approximately equal to voltage applied, divided by the series resistance of the resonant circuit, so that approximately 2 amps can be drawn from the 12v supply. Using a triangular shaped wave form derived by charge/discharge curves of a timing capacitor when applied to the voltage controlled oscillator (Figure 2), the frequency is varied so that the tuned circuit can be brought to resonance 10 times per second using the applied 5Hz frequency. Maximum field strength is still obtained at fR giving good output field strength, however reducing battery drain by 80%

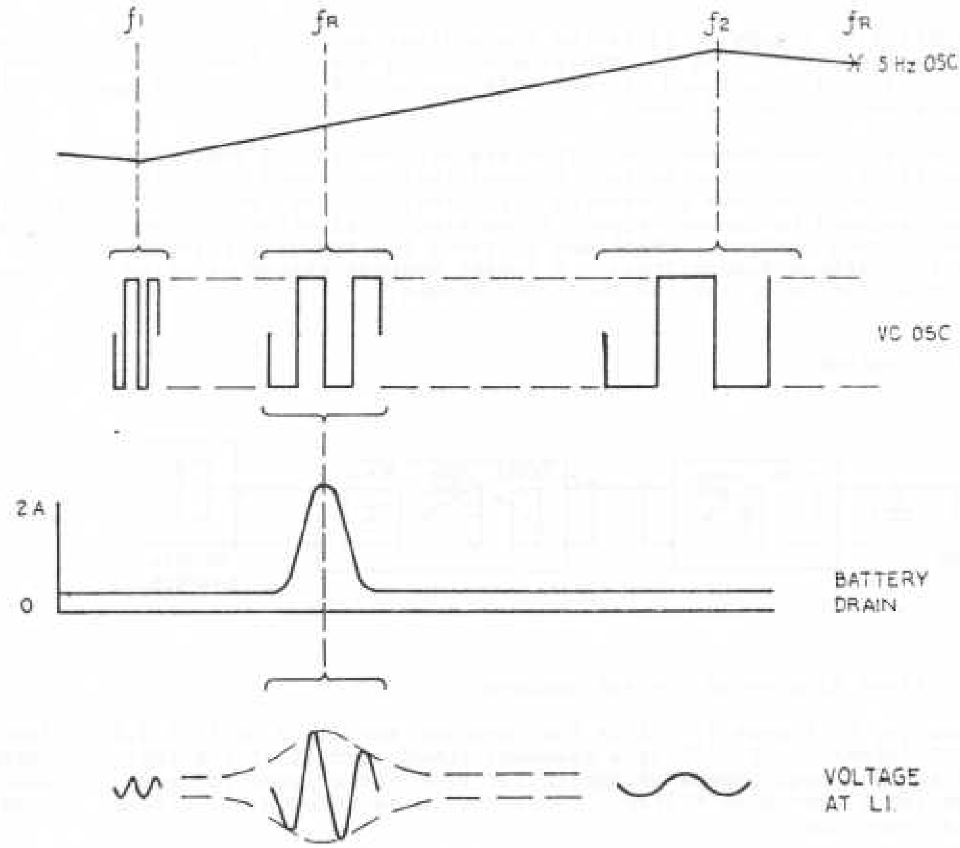

Figure 2. Modulation of the output to reduce battery drain.

Unfortunately the RDF described does not have an adequate band pass to allow transmission of voice frequency.

$$f1 - f2 = \frac{fR}{Q} \qquad Q = \text{gain of L1 at fR} = 60 \text{ times}$$

$$= \frac{1800}{60}$$

= 30Hz

or 1,785Hz to 1815Hz

To convey speech intelligibly a band pass of 1 KHz about a fR of 1 KHz was tried successfully. A tuned circuit of unity gain is therefore required.

$$Q = \frac{fR}{f1 - f2}$$

$$= \frac{1000}{1000}$$

= 1 or unity

The electromagnetic voice transmitter

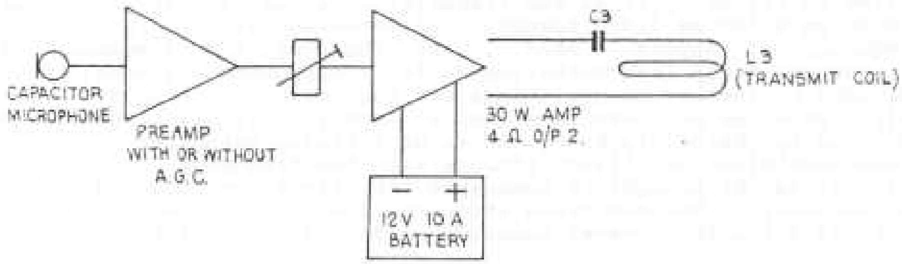

Figure 3. Block diagram of the voice transmitter.

Referring to Figure 3, L3 is the transmitter aerial, a coil consisting of 2 by 100 metre lengths of 1 sq mm insulated building wire to form 2 turns 32 metres diameter. L3, C3 is a tuned circuit, fr approx 1 KHz, f1 - f2 approx 1 KHz. Series resistance at fR > 4 ohms.

A 30w car stereo booster amplifier was divided into 2 amplifiers (one for cave transmitter, other for surface transmitter) and used to drive the tuned circuit. A front end from a cassette recorder having an inbuilt capacitor microphone was used to convert speech to an electrical signal. The circuit used had automatic gain control, which was suitable for the cave transmitter but not desirable for surface transmitter. A preset control allows matching of levels for correct operation of the two amplifier stages.

The R.D.F. receiver

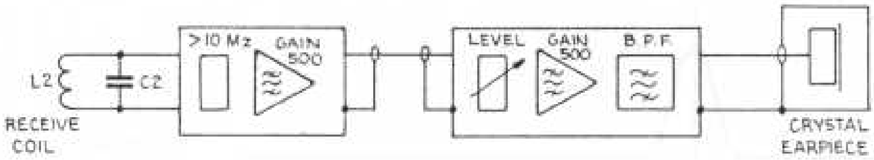

Figure 4. Block diagram of the RDF reciever.

Referring to Figure 4, L2 is the receiver aerial, a coil of 2,200 turns on a 500 mm ID former. L2, C2 is a resonant tuned circuit at 1.8 KHz. The signal is amplified by a high impedance amplifier then via a level control to another gain stage and a band pass filter. Note shielding through all stages including the crystal earpiece.

The received signal (from the transmitter) is that of a 'Warble" (i.e. 1.8 KHz pulses at a 10 Hz rate).

The electromagnetic voice receiver

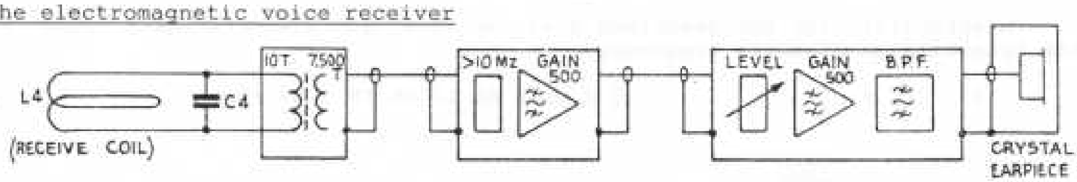

Figure 5. Block diagram of the voice receiver

Referring to Figure 5, L4, C4 are similar components to L3, C3 of the voice transmitter except that they are parallel tuned. Impedance matching is achieved using a transformer (1/P'Z'4 O/P'Z' 2.25M).

Although the amplifier stages appear very similar to the RDF receiver described earlier their high/low roll off frequencies were tailored to the bandwidth of the voice transmitter, 700 Hz to 1.7KHz.

The electro-magnetic transceiver

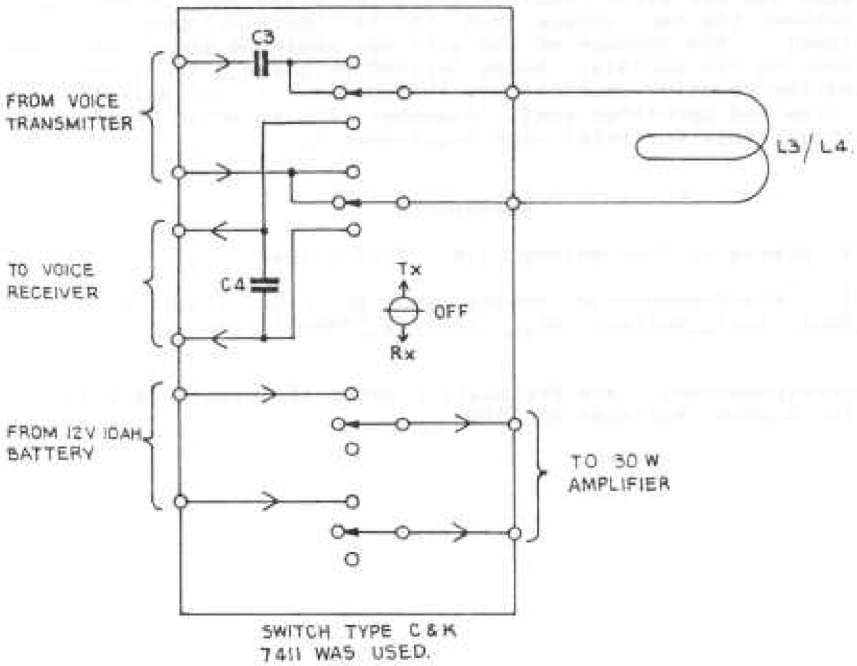

Figure 6. Switching circuit for the transceiver unit. Note: aerial is connected to transmitter in the switch centre position before 12V supply is turned on to transmit.

The switching diagram (Figure 6) shows how the units are combined to share the common aerial. Both cave and surface transceivers are similar. The aerials must be located one above the other (hence the use of RDF to locate the aerial's axis). (Figure 7).

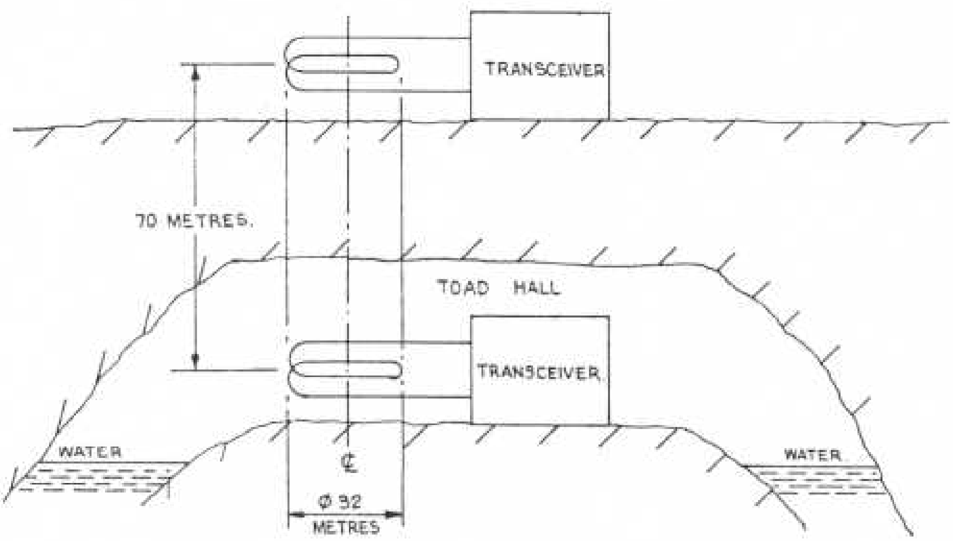

Figure 7. The relationship between the two aerials once radiolocation had succeeded.

The system in use

As previously mentioned a pre-determined switch-on time was made. The RDF transmitter was turned 'ON' for 25 minutes then 'OFF' for 5 minutes. This 'OFF' time was used to establish communications; if not made the cycle was repeated.

The communications system worked very well, however due to limited developmental time and no field measurements it is felt that many improvements can be made. For instance the transmit/receive coils' inductance was never measured but thought to be about 0.6 mH.

From actual use the first receiver amplifier stage had too much gain; the gain control between the two stages had to be near minimum to receive an undistorted signal. The concept of the unit was designed about the close mutual coupling between the two aerials, being derived by large coil diameter (approx. 32 metres) and the relative spacing between (approx. 70 metres) (Figure 7); if developmental time had permitted small diameter coils would have been tried making the unit suitable for other cave requirements.

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AUSTRALIAN AQUATIC CAVERNICOLOUS AMPHIPODS

Brenton Knott

Abstract

The purpose of this paper is to acquaint speleologists with preliminary results of recent researches into the amphipodan fauna from aquatic ecosystems of Australian caves, with particular reference to Western Australia. Attention is focussed particularly on the systematic and zoogeographic significance of this fauna.

INTRODUCTION

The phylum, or subphylum, or superclass, or class Crustacea (the rank allocated this taxon depends upon whichever authority you follow (Bowman and Abele, 1982)) is defined for an assemblage of principally aquatic invertebrates which display wonderfully confusing morphological diversity. The larger crustaceans such as crabs, crayfish and shrimps tend to be better known generally than are the majority of forms, most of which range in size from about 1-2cm to microscopic (less than 1mm). Crabs, crayfish and shrimps belong to the taxon Malacostraca, as do those crustaceans classified within the orders Amphipoda and Isopoda. Amphipods and isopods are sufficiently small (few exceed a length of about 2cm) and inconspicuous so that fortunately only a limited vernacular vocabulary has developed about them. Amphipods are sometimes referred to by the ugly name 'scuds' in America and by the confusing term 'freshwater shrimps' in Europe (Williams, 1980). How many crustaceans are colloquially called 'shrimps'?! Terrestrial isopods, 'slaters', are well known to most urban dwelling Australians.

It is quite usual in discussions on crustacean issues for amphipods and isopods to be bracketed together, and certainly there are similarities which serve to generate confusion and create difficulties for the novice unprepared for the subtleties of crustacean taxonomy and professional carcinologist alike essaying to identify specimens. Amphipods and isopods, for example, lack a carapace but whatever similarities do exist between both groups are not indicative of close phyletic relationship (Siewing, 1963). Furthermore, they are predominantly littoral marine crustaceans but members of both groups have successfully invaded most available aquatic habitats, including those of surface and subterranean fresh waters. It is convenient to refer to the fauna from open surface fresh waters as epigean; those from underground or phreatic habitats as hypogean. Indeed, amphipods and isopods are the best represented of the crustacean groups found in ground water (Vandel, 1965); others include syncarids, mysids, decapods, ostracods and copepods) and in some areas dominate the fauna of cave streams - for example in the Appalachian cave streams of eastern America (Culver, 1982).

The situation in Australian cave streams seems, given our present limited knowledge, more akin to that pertaining to caves in Britain and the Caribbean, for example, where although ispods do occur in cave streams, amphipods are much more commonly encountered and presumably contribute more to the biomass and ecosystem dynamics. Just why amphipods should be more successful than ispods in the underground poses an interesting problem which will be neatly sidestepped here so that for the remainder of this paper attention can be focussed on the aquatic amphipods from Australian caves. Significant discoveries of amphipods from Australian caves have been made during the past few years, but it is also fair to warn you that this paper really is a little premature, for considerable taxonomic work remains to be carried out and what follows is a litany of taxonomic uncertainties.

Amphipod taxonomy is in a state of flux at all levels of the taxonomic hierarchy from familial to species level. Different family arrangements have been proposed by Bousfield (1977) and Barnard and Barnard (1983) for example; and Karaman and Barnard were not always unanimous in their conclusions in their jointly authored paper presented to the International Conference on the Biology and Evolution of Crustacea held in Sydney in 1983 (Barnard and Karaman, 1983,pp.59-60). Bousfield (1977) has suggested that the taxonomic dificulties may stem from the possibility that amphipods are undergoing a phase of adaptive radiation; the fault may lie, however (if fault there be), with taxonomists not having given due cognisance to character variation. Prof. W. D. Williams of Adelaide University has been revising the Australian freshwater amphipods for more than a decade now, and the results of his studies await publication. Quite understandably so; character variation in the Western Australian forms alone presents a most formidable problem. In a paper included in a forthcoming publication on the groundwater fauna of the world being edited by Dr. L. Botosaneano, Williams (in press) summarises the published information on the distribution and systematics of Australian freshwater amphipods as follows and following Barnard and Karaman (1983) comments "that Australia has been a major evolutionary centre and refuge for freshwater amphipods.

Williams cites 26, possibly 27, species of epigean, and 3, possibly 5, species of hypogean amphipod, none from caves. I think it is safe to assume that this is a very conservative estimate of the number of species of freshwater amphipods in Australia. Of the 3 forms listed as definitely hypogean, all are endemic to southern-western Western Australia and two, *Protocrangonyx* sp. and *Uroctena* sp., have been collected only from epigean situations but are regarded as hypogean because they possess one or more characteristics commonly considered as adaptations to a subterranean existence: slender transparent body, creamy-white colour, eyeless. Thus *Protocrangonyx* sp. has been collected only from the mouth and outflow runnel of springs, and *Uroctena* sp. are typically found now in temporary streams, particularly at the base of granite areas of the jarrah forest. Only *Hurleya kalamundae* has been collected from a well, and then but once, in the suburb which gave the species its name.

AMPHIPODS IN W.A. CAVES

Jennings (1975) delineated 5 major areas of Karst in Western Australia, and caves occur in 4. Cavernicolous amphipods have been found in the 3 areas surveyed to date - south-west, Nullarbor and Exmouth.

Caves are not uniformly distributed throughout the south-west zone, but are restricted to circumscribed areas (Lowry, 1980) such as at Yanchep, where the shallow cave streams have yielded the most extensive fauna of aquatic cavernicoles from Australia known to date. In all, 18 species of aquatic cavernicole have been discovered from caves at Yanchep. An account of the studies on the Yanchep cave fauna is being prepared for publication elsewhere.

Yanchep

Amphipods representing 3 genera, 4 species in all, are known from Yanchep. All are associated for the most part with the mats of tree roots lining the streams. This fact in itself is quite significant. The almost complete absence of primary producers in cave ecosystems means that food must usually be imported and that cave communities tend to be dominated by decomposer organisms (Culver, 1982). Tree roots serving as an important energy source for cavernicoles is evidently more frequently observed in caves of tropical than temperate areas and is particularly important in the lava tube and limestone caves of Havaii (Howarth, 1983).

The amphipods from Yanchep are as follows:

1) *Austrochiltonia subtenuis*, from 4 out of 16 study sites.
2) *Perthia*, 2 species; one, *P.acutitelson*, from 5 out of 16 study sites, the second, *Perthia* sp. nov., found at only one site.
3) ?*Hurleya* sp. from 3 of the 16 study sites.

Austrochiltonia subtenuis: we cannot even be certain about either name! It has been suggested (see the Barnards, 1983) that the genera *Afrochiltonia* (described in 1955) and *Austrochiltonia* (described in 1959) are synonymous, and if this view is upheld (a view doubted by some local amphipodologists at least), then *Afrochiltonia* takes precedence. *A.subtenius* is reasonably widespread in south-western Western Australia, and also occurs in Western Victoria and Tasmania (Williams, 1962). Another species, *A.australis*, occurs in eastern Victoria and Tasmania, and the suggestion has been made than *subtenuis* and *australis* are synonymous. If so, *australis* takes precedence since it was described in 1901, a year before *subtenuis*. Now the cave specimens from Yanchep called *Austrochiltonia subtenuis* do exhibit some morphological differences from the surface dwelling counterparts, even from Loch McNess, and these differences have been described in detail by Burt (1982). For example, the cavernicoles are smaller, and white (not green/brown), and show some small regression in eye expression. Burt also found that the number of segments in the first antennae is significantly correlated with body length in both hypogean and epigean specimens, but slopes of the regression of antennal segment number against body length were significantly different, with proportionately greater increase in segment number per unit body length occurring in the hypogean specimens. Furthermore, Burt also found that mean clutch size per female was significantly lower in hypogean than in epigean specimens. However, the mean egg volume in hypogean specimens was significantly greater than for epigean specimens. Vandel (1965) regarded the larger egg volume of cavernicoles to be an adaptation to a subterranean existence, the slower maturation leading to more advanced embryonic development being a response to limited food supplies. Nevertheless, a limited allozyme study on proteins from cave and surface specimens from Yanchep indicates very little genetic divergence between the two stocks, insufficient to validly recognise separate species status for the cavernicoles, but clearly they are undergoing incipient speciation.

Perthia: of the two species of *Perthia* from the Yanchep caves, the most widely occurring is tentatively identified as the species *P.acutitelson*; the second, clearly a new species, was found at only one site.

The genus *Perthia* was described for amphipods abundant in permanent steams in both the forested areas and the sandy coastal plains of south-west Western Australia. Two species have been described, but again doubt must be raised about the validity of each. Cavernicolous amphipods previously recorded from Mammoth, Calgardup and Strong's caves by Lowry (1980) probably belong to the species *P.acutitelson*, a suggestion based upon specimens collected from the former 2 caves during the last two or three years. All these cave forms tentatively named as *P. acutitelson* show some slight morphological change from their epigean counterparts, but it must be emphasised that the genetic and taxonomic relationships between the hypogean and epigean populations of *Perthia* remain an interesting and significant study for the future.

The second species of *Perthia* from Yanchep is a true cavernicole in that it is colourless, and eyeless. Allozyme studies confirm it to be genetically distinct from *P.acutitelson* and other epigean samples of the genus collected from Perth.

"*Hurleya*": blind, white amphipods cited in Burt's thesis as *Hurleya* sp. were found at 3/16 sites at Yanchep. This name is probably wrong, for Williams considers these amphipods to be neoniphagids. However, no attempt has been made either in Burt's thesis or here to correct the name for we do not wish to pre-empt Williams' studies. The centre of neoniphagid diversity is south-eastern Australia and Tasmania, but a species occurs near Albany, W.A. The Yanchep forms, if neoniphagids, then, must be regarded as zoogeographical relicts.

It is also appropiate to record here that neoniphagids were found recently in caves of the Florentine Valley by Tasmanian speleologist S.Eberhard.

In summary, of the Yanchep Cave amphipods, there is evidence for at least two separate invasions into the underground, "*Hurleya*" and *Perthia* sp. nov. taking the plunge first and in the long distant past. The second invasion is currently under way with *A.subtenuis* and *P.acutitelson*, and it is extremely doubtful whether the epigean and hypogean populations have yet achieved reproductive isolation. It is, of course, a moot point whether either invasion was synchronous for the two species involved.

Nullarbor Caves

In view of the statement by Richards (1971, p.29) in her comprehensive study on cavernicoles from the Nullarbor Plain that "no aquatic fauna has been discovered in any of the Nullarbor lakes", the finding by Messrs. Barnes and Poulter of amphipods in Nurina Cave is unexpected. The discovery has already been recorded in the A.S.F. Newsletter (Knott, 1983), and brief descriptions of the water chemistry and systematic position of the amphipods given therein.

All told, 9 specimens have been collected, the last collection of 6 being made on 4/12/82 when it was estimated by Poulter (pers. comm.) that 30 specimens were swimming in the lake. Salinity of Nurina Lake is near sea water (31.7% compared with salinity of 36.0% of water from the Great Australian Blight (Lowry, 1970). The amphipods represent a new species probably of *Melita*. The Barnards (1983) describe *Melita* as a 'basic kind of gammarid to which many other taxa bear comparison'. They recognise 61 species, mostly marine, cosmopolitan ranging from littoral to abyssal but with some estuarine and anchialine species. Three species are recorded from Australia, two from the Swan River estuary and the other marine littoral. Undoubtedly this is but a fraction of the Australian *Melita* fauna.

The Nurina population probably represents a marine relict remaining from the transgression of a higher sea level. Stock (1980) considers that population stranded inland by receding sea levels have been important in the evolution of the genus *Pseudoniphagus*, amphipods distributed predominantly about the area of the western Mediterranean and coastal Iberian peninsula.

Exmouth

The subterranean fauna of blind fish and shrimps from the Pleistocene reef about North-West Cape has been known now for two decades and more. Cape Range itself provides numerous caves, dry for the most part, but fresh water occurs in two - a small stream in Shot Hole Tunnel, a pool in Dry Swallett.

Both aquatic habitats harbour large populations of an amphipod belonging to the *Victoriopisa-Eriopisa* complex. Both populations are apparently conspecific. Judging by the disjunct distribution of the fish and shrimps on the surrounding Pleistocene reef, and amphipods in the caves of the Cape Range, there are two quite discrete water bodies involved.

Other species of this generic complex show a difficult to interpret, although basically circum Indian Ocean, distribution. Species of *Victoriopisa* have been described from Chilka Lake in Orissa, East India, the Andaman Islands, South Africa - and S.E. Australia!

CONCLUSIONS

To conclude: amphipods there certainly are in Australian caves. Williams (in press) makes the point that these crustaceans are absent from northern Australia (and New Guinea) because the climate is either too warm or too dry. The discovery of amphipods at Exmouth extends the known northern limit of their range quite significantly, but they may well occur even further north - in caves of the Kimberley or Chillagoe areas, for example. 'Shrimps' from the Chillagoe caves may be decapod crustaceans (as Ikin (1980) noted with extreme reservation) - they may also be amphipods. Certainly warmth cannot be invoked to explain an absence of amphipods from an area - for amphipods occur in ground waters of the Caribbean, and in the caves in Sarawak.

Help would be greatly appreciated from speleologists, particularly those venturing into caves in remote areas. Even mere reports on the occurrence of animals and/or tree root mats are valuable pieces of information to have. Aquatic cavernicoles are generally delicate organisms and extremely difficult to keep alive for any extended period of time out of the cave environment. Consequently animals should not be removed unless there are good facilities immediately available to maintain the animals alive, or else properly fix and curate them. If good fixatives such as 70% ethanol, or formalin diluted to a strength of 5-10% using water the animals actually live in, are available with the caving expedition, then one or two specimens carefully preserved along with complete collection data (site, date, name of collector, microhabitat from which animals were collected) would be gratefully received, duly acknowledged, and must inevitably advance the cause of Australian speleology.

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CAVING POTENTIAL OF AUSTRALIAN AEOLIAN CALCARENITE

Susan White

Abstract

Although Australia is limited in karst areas by world standards, the extensive areas of aeolian calcarenite (dune limestone) are often ignored by cavers. This paper describes the distribution and characteristics of aeolian calcarenite karst in Australia and discusses its caving potential.

INTRODUCTION

Australia is often reported as having relatively scarce karst and cave resources (Jennings, 1965 and 1975), as shown by a comparison of maps of karst cave areas of Australia and the USA published by Jennings (1983). Attention of cavers is often focussed on better known localities which are similar to caving areas in Europe or America. Concentration by many cavers on the karst areas where the limestone is massive and well jointed and which have long, deep or vertical caves has meant that other areas of potential are ignored.

Australia has more areas of aeolian calcarenite or dune limestone than any other continent (Williams, 1978; Jennings, 1983). Jennings (1983) estimated between 50 and 100 000 km2, and this may be conservative (my unpublished observations). The Nullarbor Plain limestone, in comparison, is 200 000km2. Comparing known cave numbers, the Nullarbor limestone has about 225 known caves whereas there are about 250 aeolian calcarenite caves in SW Western Australia alone, and probably a number of 600 to 700 is a realistic total for the caves in aeolian calcarenite in Australia.

AEOLIAN CALCARENITE

Aeolian calcarenite is limestone composed of sand-sized fragments deposited by wind. It is often referred to as aeolianite or dune limestone, and can vary in its purity (that is, the amount of calcium carbonate present), often containing quite high amounts of insoluble material such as quartz. It is generally less compacted, more porous and more permeable than the well jointed, massive and compact limestones of the well known caving areas of Eastern Australia such as Tasmania or Buchan. It has few, if any joints and the water moves through the limestone along lines of primary permeability. Many of the differences in the karst forms are due to the differences in rock characteristics and many are the result of the length of time since the rock was deposited. Most aeolian calcarenites in Australia are Pleistocene in age (less than 3My BP) whereas most of the massive limestones of the karst barres of South Eastern Australia are of Palaeozoic age (older than 225My BP).

DISTRIBUTION

Many coastal areas of Australia have aeolian calcarenite deposits. As seen in Figure 1, such areas extend from Shark Bay in Western Australia to Wilsons Promontory and Flinders Island. Not all these deposits are known to have caves: some have many and others are known to have few or none. Areas known to have caves in aeolian calcarenite include:

Western Australia: Augusta, Cape Range, Eneabba, Jurien Bay, lower SW coast, Margaret River, Yallingup, Yanchep, Nullarbor.
South Australia: Eyre Peninsula, Kangaroo Island, lower SE, upper SE, Nullarbor.
Victoria: Bats Ridge, Cave Ridge, Glenelg, Kentbruk, Puralka, Strathdownie, Cave Hill, SW, Warrnambool, Cape Schank.
Tasmania: Cape Barren Island, King Island, Flinders Island.

The eastern coasts of Australia from Queensland to eastern Tasmania are characterized by quartz sand dunes (Jennings, 1967; Bird, 1967); aeolian calcarenite is found on the coasts characterized by calcareous sands - the southern and western coasts of the continent. The source of the calcareous sand is thought to be reworked Tertiary limestones now offshore (Kenley, 1971). Coral sand is of course found on the beaches of northern Queensland, but karst features have not been extensively reported.

CHARACTERISTICS OF AEOLIAN CALCARENITE KARST

The characteristic caves are shallow, linear systems with horizontal passages which have formed under ahardened cap rock or kankar layer in the dunes. Occasionally there are caves with more than one level but this is rare. Many of the caves are sinuous rather than straight and some are horizontal networks.

The cap rock is a cemented, relatively hard layer within the dune, formed as a result of the solution and re-deposition of calcium carbonate under subaerial conditions. Breakdown has been a significant aspect of most caves; many have colapse entrances and rock-pile floors. Passage and chamber shape has been extensively modified by collapse processes. The cave floors also show clastic sediments derived predominantly from the insoluble residues of the calcarenite host rock. The caves often contain a range of calcite speleothems - stalactites, stalagmites, straws, cavecoral, helictites and flowstone. Moonmilk is present in the caves in some areas. This is unusual as it is a much less common speleothem in many other karst areas than calcite flowstone deposits.

Solution pipes, roof avens and foibes are common. Karren forms are not common on the exposed limestone, but some examples, especialy of mottling, appear on areas of exposed cap rock. Exposures of the more cemented cap rock are generally restricted to the collapse cave entrances. Many of the areas show small collapse dolines as entrances to caves and some have interdune swales that have been modifies by solution.

Cave potential is, however, high. Jennings (1967, p.80) described the SW of Western Australia as having "such a great array of developed and potential 'tourist' caves". Areas in south western Victoria have a very high number and variety of caves in the aeolian calcarenite compared to the much more extensive Tertiary limestones. But cavers are lured by the conventional ideas of 'good' caving areas and often have ignored inteesting areas because the caves do not correspond to the usual types. Most of the caves in these areas are small and horizontal but occasionally spectacular systems are found - Strongs Cave, Augusta, WA is an example.

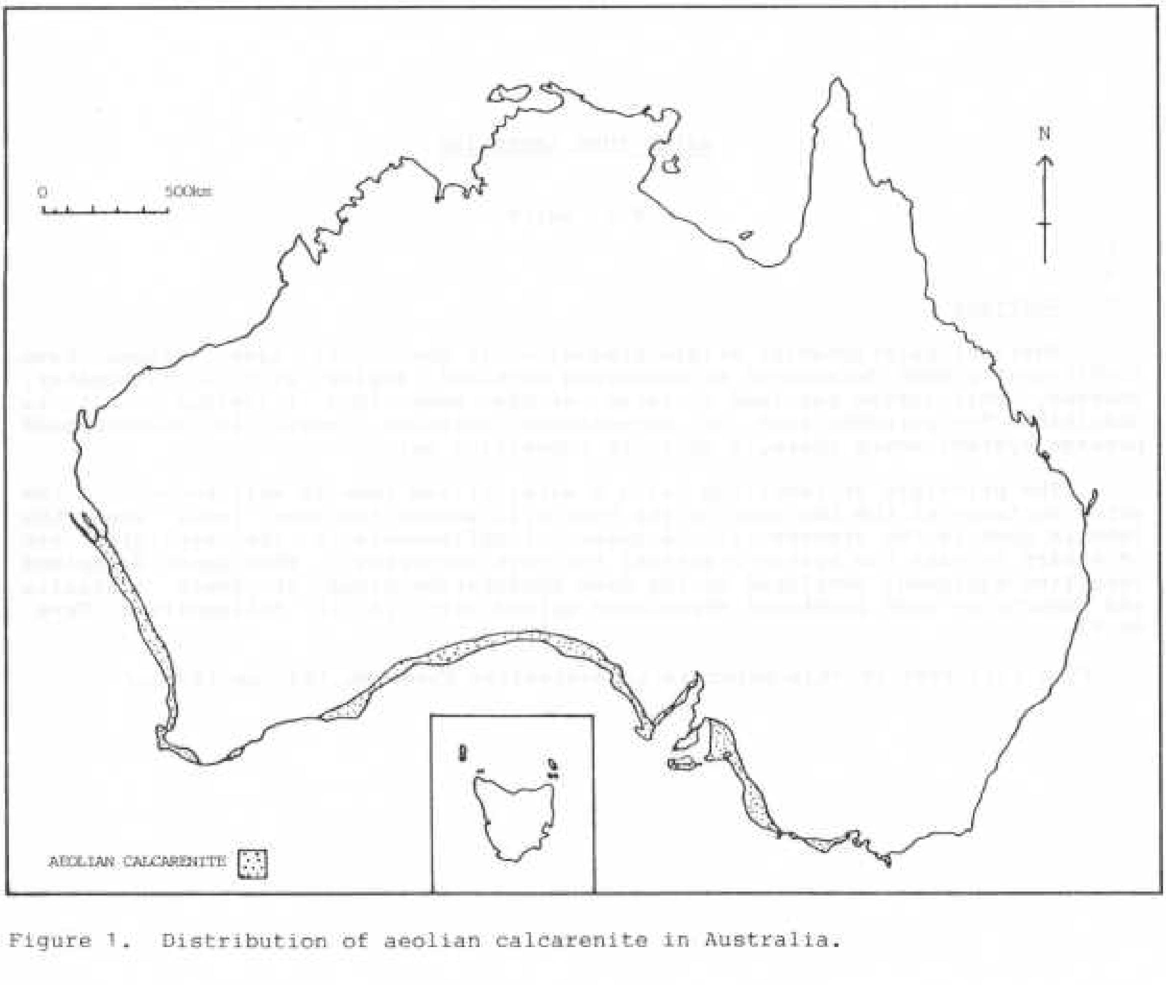

Figure 1. Distribution of aeolian calcarenite in Australia.

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WATER TUBE LEVELLING

N.I. Smith

Abstract

Vertical relationships within predominantly horizontal cave systems have traditionally been determined by measuring vertical angles with a clinometer. However, this system can lead to large errors over long traverses. It is unsuitable for purposes such as determining relative levels in superimposed passage systems where there is no short connecting path.

The principle of levelling using a water-filled tube is well known - the water surfaces at the two ends of the tube will assume the same level when the tube is open to the atmosphere. A number of refinements to the apparatus are necessary to make the system practical for cave surveying. This paper described levelling equipment developed by the Cave Exploration Group of South Australia and reports on some practical experience gained with it in Mullamullang Cave, 6N-37.

(The full text of this paper is in Australian Caver No.109, pp 10-13.)

DIVING AT COCKLEBIDDY CAVE

Ron Allum

Abstract

Cocklebiddy Cave (Western Australia) lies 200 km west of the South Australian border on the Nullarbor Plain. It is mostly waterfilled and represents the world's longest cave dive. In September 1982 an Australian diving expedition had increased the known length to 4.3km. This was extended to 5.85km in September 1983 by a French expedition led by F. Leguen, using motorised underwater scooters and lightweight equipment. The French party regarded the prospects for further extension as poor, since the hitherto wide pasage had become rather constricted.

The following month, October 1983, a team consisting of Hugh Morrison, Ron Allum and Peter Rogers with 11 supporting divers made a further attempt on the cave using only manual power. Theu established a camp at Toad Hall, a large air-filled chamber 4.3 km into the cave, and dived from there to the constriction which had stopped the French team. From this point Hugh Morrison continued using only one air cylinder, and continued a further 240m. He was stopped only by shortage of air. The explored length of Cocklebiddy now stands at 6.09km, and the only barrier to further exploration is the logistic problem of carrying air cylinders through the constriction.

(The full text of this paper is in Australian Caver No.109, pp 2-5.)

ANGLO-AUSTRALIAN EXPEDITION TO THE GUNNUNG SEWU KARST, JAVA, INDONESIA.

Wayne Tyson

Abstract

In August 1984, six members of the Western Australian Speleological Group joined six members of the Kingswod Caving Group (UK) in Java, and with the assistance of the Federation of Indonesian Speleological Activities explored and mapped approximately 20km of cave passage in a period of 3 weeks.

Many large river passages were found and a fair mixture of vertical and horizontal systems. The highlight of the expedition was the discovery of Luwang Jaran (Horse Pot) which was surveyed for 11km with many leads still going. This is now the longest cave in Indonesia. Six other caves over 1km long were found.

The potential for further exploration in Java is enormous, despite bureaucratic difficulties. A return expedition is planned for 1983.

BENUA CAVE, KERIAKA PLATEAU, BOUGAINVILLE ISLAND, PAPUA NEW GUINEA

Ian D. Wood

Abstract

Benua Cave is situated in the Keriaka Limestone plateau above the west coast of Bougainville Island. It was first reported by pilots during World War II and first visited speleologically by Fred Parker in 1963. The North Solomons Cave Exploration Group made a three-day visit to the cave in order to make an accurate survey. The cave consists of a single chamber, 470m along its longest length, with a maximum width of 150m and height of 170m. A river estimated at $3m^3.s^{-1}$ rises at the foot of a 100m sheer wall and flows out of the entrance. The cave contains an 18m tall stalagmite of impressive proportions. Side passages can be seen at high level but would require mechanical aids to reach.

(The full text of this paper will appear in the Australian Caver.)

INFORMATION FOR CONTRIBUTORS

SCOPE

Contributions from all fields of study related to speleology will be considered for publication. Suitable fields include Earth Sciences, Speleochemistry, Hydrology, Meteorology, Conservation, Biospeleology, History, Major Exploration (Expedition) Reports, Equipment and Techniques, Surveying and Cartography, Photography and Documentation. Comprehensive descriptive accounts of the exploration and morphology of individual caves will be welcomed, but simple trip reports and brief cave descriptions are not adequate. Papers overall should not exceed 20 printed pages in length. Contributors intending to write at greater length or requiring any advice on details of preparation are invited to correspond with the Editors. All manuscripts will be read by referees. Short 'Letters to the Editor', expressing a personal view or giving a preliminary report of interesting findings, are welcomed, and will be given preference for speedy publication.

MANUSCRIPTS

Submitted manuscripts should be in a final form ready for publication. As proofs are not normally sent to authors particular care should be taken to check for typing errors. Manuscripts should be typed, double spaced, on one side of the paper. The title should be uppercase and underlined, and the authors' names should follow. A brief and explicit summary of the notable aspects of the paper, headed Abstract, should precede the main text.

Throughout the main text major headings should be in upper case, centred and not underlined, while subheadings should use lower case, underlined and aligned with the left hand margin. Acknowledgements should be placed at the end of the text before the references, and the authors' addresses for correspondence should follow the references.

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REFERENCES

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GRAY, M.R., 1973 Cavernicolous spiders from the Nullarbor Plain and south-west Australia. J. Aust. ent. Soc. 12: 207-221.

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Figures and photographs should be kept to a minimum and generally should not duplicate information in tables or other material. Photographs should be clear black and white prints with sharp focus. Where several photographs are to form one plate they should be mounted together on white card. Any lettering required on photographs should be applied with 'Letraset'. Figures should be drawn in Indian ink on white card, heavy paper or tracing material and lettered using stencils or 'Letraset'.

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Figures and plates should each be numbered consecutively and specifically referred to in the text. The numbers should be marked lightly in pencil on the margin or back of each illustration. Captions should be typed on a separate sheet.

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The S.I. system (Australian Standard AS 1000) should be used unless citing historical data, in which case the original units should be quoted and appropriately rounded metric equivalents added; e.g. "100 feet (30 m)".

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