CAVE DIVERS ASSOCIATION
OF AUSTRALIA
RESEARCH GROUP

REPORT No. 1

KILSBYS HOLE

FEBRUARY 1983

CAVE DIVERS ASSOCIATION OF AUSTRALIA (INC.) - RESEARCH GROUP

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KILSBYS HOLE STUDY

February 1983

Please note: This report was originally prepared by research team members Robin Garrad, Jenny Hiscock, Peter Horne and Peter Stace, using an early type of computer and digital recording medium (5.25", 750-kilobyte floppy disk) which has since been lost. Due to degradation of the few known hard-copies of the report and with the cessation of the CDAA Research Group in the mid-1990s, one of the original co-authors, Peter Horne, decided to type up this version manually in June 2003 using Windows 98/Office 2000 software.

While every effort was taken to ensure that this copy was typed up as close to the original as possible (including general page layouts and numbering etc except in some instances where obvious spelling or factual/typing errors were found), it is possible that some other aspect/s may have slipped past, and the author therefore offers apologies should this have occurred. Additionally, because the original report was never authorized for publication by the Property Leaseholders of that period (and can no longer be obtained as a consequence of the passage of so many years), certain other points have been deleted or modified so that this report could be made more generally available.

This report was compiled from notes that were prepared by members of the Cave Divers Association of Australia Research Group in July 1983.

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ACKNOWLEDGEMENTS

The success of this study is attributed to the efforts of many individuals and organisations.

We are indebted to the Department of Defence Research Centre and the Department of Administrative Services for allowing access to the cave. This study could not have been undertaken without their permission or the generosity of Mr and Mrs Kilsby who allowed access to their property.

Peter Girdler, the Defence Research Centre representative, deserves special mention for the efforts he made to liaise with the C.D.A.A. Research Group and thus enabling the success of access negotiations.

The support and assistance of the following individuals and organisations for processing of samples and discussion of results is gratefully acknowledged.

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Thanks must also go to the individual members of the Research Group who compiled the information in report form, and to Jenny Hiscock for her efforts in the final presentation and typing of this Report.

SUMMARY

This study represents the most advanced and thorough study of a waterfilled cave feature in Australia. During the 6 days allowed for access a wide variety of fields were investigated including Geology, Hydrography, Palaeontology, Biology and Sedimentology. However the most significant task undertaken was the detailed surveying of the entire cave which required over 90% of the study time. The map produced from this data is of the highest accuracy and detail believed to be possible for a waterfilled feature of this size and is the first major sinkhole to be surveyed to this level.

Due to the effort required to undertake the survey very little time was available for study in the other fields. Consequently an insufficient amount of data was collected for proper analysis and few conclusions can be drawn although many interesting theories and questions have been proposed.

Nevertheless, a number of significant factors have been discovered. Previously unknown phototrophic formations, rare underwater animal and vegetable life, unusual silt and calcium deposits, abnormal orientation of the cave, and a lack of temperature variation are some of these unique features. Together with these there is the high possibility of the existence of significant fossil deposits of extinct animals making this one of the most interesting and diverse sinkholes in the area.

The problem now exists that we have come to realize how little we know about this and indeed all of the waterfilled caves and sinkholes. More survey work is required to check orientation and joint control of the cave. Much of the finer detail of features such as the air pockets are as yet to be taken and more floor, roof and wall details are required. A highly accurate survey of the fossil site would be required before any amounts of material are disturbed together with a photographic mosaic of the fossil beds. In fact in all fields touched on in this study further work is required and it is hoped that at some suitable time an opportunity will again be given to continue this most worthwhile and interesting project.

1 INTRODUCTION

1.1 Study Background

Most of the large waterfilled sinkholes and many of the smaller caves in the Mt. Gambier region have been surveyed to some standard or other by individuals of the Cave Divers Association of Australia and the Cave Exploration Group of S.A. (C.E.G.S.A.). Members of C.E.G.S.A. have been responsible for the surface surveys of the sinkholes and divers have made preliminary surveys of the underwater sections in recent years. One of the sinkholes that has been unavailable for study and comparison with the other caves is Kilsbys Hole. The Department of Defence has held a lease on the sinkhole since about 1969, effectively preventing scuba diving in this location since that time.

Since Kilsbys Hole is located in the area of greatest concentration of large deep sinkholes in the Mt. Gambier region (see Section 2.1), it is of particular interest. There have been no maps available with which to compare it with other sinkholes other than memory maps drawn by divers who visited the cave some fifteen years ago. To appreciate the place of Kilsbys Hole among the large sinkholes, an expedition to the location was necessary. For example, it was not known if this cave was of similar shape to the others, similar water properties (with regards to thermoclines, chemistry, etc.), similar lifeforms (this cave had not been disturbed by regular diving visits as have other sinkholes) or if it contained fossil bones of significance (apparently bones have been collected from this cave previously).

An application was made to the Defence Research Centre requesting permission for a small group of suitably qualified divers to have limited access to Kilsbys Hole to undertake a study of the cave's features. The major aim of the study was to carry out a detailed underwater survey of the cave as well as collect water samples, biological life, fossil bones and measure water temperatures. From these studies and other observations it was hoped that some comparison in geological and other terms would be possible between Kilsbys Hole and the large sinkholes nearby. Permission was given for the study to take place over two weekends in February 1983.

1.2 Cave Divers Association of Australia – Research Group

The CDAA Research Group was formed as a sub-committee of the Cave Divers Association of Australia to pursue the research and mapping of underwater caves and sinkholes in the Mt. Gambier region. Prior to the formation of this group, work of this kind which had been undertaken was done by individuals and so much of the information gained had been lost or dispersed. It is hoped that the CDAA Research Group will prevent this happening in the future by providing a central register of research reports and by instigating and carrying out well organised research programs that relate to cave diving and the region of interest (in this case, Mt. Gambier).

1.3 Study Personnel

All persons who took part in the underwater survey work of Kilsbys Hole are members of the Cave Divers Association of Australia (Inc.) and hold CDAA qualifications suitable for diving in this location. Most of the persons have considerable cave diving experience (as shown by the fact that all but one is qualified to Category 3 standard) as well as experience in previous expeditions and studies of caves and sinkholes.

Peter Stace	Study Co-ordinator Category 3 cave diver with 13 years experience. Experience in surveying of dry caves, mapping of underwater caves, map production and water sampling techniques.

The other participants in the study are as follows in alphabetical order:

Martin Garrad	Category 3 cave diver with 7 years experience. Previous involvement with mapping of Fossil Cave and collection of fossil bones.
Robin Garrad	Category 3 cave diver with 8 years experience. Major involvement in organisation of Fossil Cave expedition 1979.
Peter Girdler	Category 2 cave diver recently, however previous experience of cave diving some 15 years ago. Representative of Defence Research Centre.
Jenny Hiscock	Category 3 cave diver with 9 years experience. Previous involvement with mapping Fossil Cave and collection of fossil bones.
Peter Horne	Category 3 cave diver with 8 years experience. Previous involvement with mapping, temperature surveys, and specimen collection (biological) from Mt. Gambier sinkholes.
Ian Lewis	Category 3 cave diver with 12 years experience. Cave surveying experience (dry) and an active interest in geology of the Mt. Gambier sinkholes (currently undertaking Honours Geography on a topic in this field).

Phil Prust	Category 3 cave diver with some 18 years experience in Mt. Gambier sinkholes, Nullarbor caves and Florida caves. Previous involvement with mapping of underwater caves at Mt. Gambier and the Nullarbor caves.

Photograph 1. Study Personnel
Back row l-r: Jenny Hiscock, Peter Horne, Martin Garrad, Peter Girdler.
Front row : Peter Stace, Ian Lewis, Robin Garrad.
Absent from photo: Phil Prust

1.4 The Cave

Location

Geographical – about 9 km south west of Mt. Gambier on the property called 'Bringewood'
Cadastral – Hundred of Blanche, Section 102
Reference – L46 (C.E.G.S.A.)

Access

The property in which L 46 lies is owned by Mr and Mrs R. Kilsby, 'Bringewood', Box 458, Mt. Gambier 5290. The area surrounding the cave is leased by the Commonwealth Government and is used by the Defence Research Centre, Salisbury, S.A. The Chief Property Officer of the Department of Administrative Services is responsible for administration of the leased land. This area is not open to the public and access is restricted. This study was given permission for limited access only.

CDAA Category

Due to access not being available to sport divers, this cave has not been given a category rating by the Cave Divers Association of Australia. It was felt by this group of visiting divers that the sinkhole had similar features to other Category 2 holes.

Cave History

The area around Kilsbys Hole was originally surveyed in 1857 and interestingly the Land Department plan produced from this survey does not show Kilsbys Hole or Bullock Hole whilst it does show Black Hole (The Devils Punchbowl), the Sisters (Two Wells) and most other open sinkholes in that region. According to that survey the land surrounding Kilsbys Hole was good pasture with limestone and flint outcrops and apparently little tree or bush cover which may have concealed the mouth of the cave. Perhaps because Bullocks and Kilsbys Holes have smaller entrances, they were not seen during this first survey.

Very little of the early history of Kilsbys Hole is known, although it is believed that it was used as a watering point for stock travelling the nearby stock route. Vertical rope scars can be seen today in the sides of the small window entrance which were probably made when buckets were hauled up in those early days.

Originally this area was a part of the property now known as Barnoolut and the cave apparently remained unnamed until about 1962 when members of the Underwater Research Group (a group of Adelaide divers) named it after the owner at that time Mr Dene F.A. Kilsby father of the present owner.

During Easter of 1962 members of the Cave Exploration Group of S.A. visited the Mt. Gambier Area to survey and explore many of the cave features including Kilsbys Hole which they were shown by members of the U.R.G. A survey was made and a number of exploratory dives undertaken. It is noted in CEGSA trip records that the water was crystal clear with a small amount of floating weed on the surface and that the bottom was very clean. Water temperatures of 15.5^{o}C on the surface and 15^{o}C below the surface were measured.

In the late 1960's, as sinkhole diving began to flourish, Kilsbys Hole became a popular dive, although, because it was difficult to enter, requiring a home-made ladder, visitors would have been less in number than at many of the other 'walk in' sinkholes. Nevertheless the clear water attracted many divers and dives to an excess of 40m were apparently commonplace.

In 1969 on the 6th of April the first cave diving fatalities in Australia occurred in this cave when 2 young men undertook a dangerously conceived dive. Both were totally inexperienced in cave diving and indeed had almost no scuba diving experience at all. The factors which brought about their deaths still remains unsatisfactorily explained despite accurate knowledge of the cave's features now being available. It can only be concluded that whilst foolishly attempting to dive beyond their capabilities they experienced a problem they were unable to deal with which then led to the situation becoming irreversible.

Some diving continued after the drownings until late 1969 when the Defence Research Centre (then the Weapons Research Establishment) took control of the area immediately surrounding the cave for the use as a testing site. The D.R.C. had apparently looked at a number of different sinkholes but had decided on Kilsbys Hole because its small mouth was more suitable for the construction of gantries and because of the reliability of the clear water. At that time duckweed covered the surface of the lake, from time to time. The duckweed was removed by sucking it from the surface and has not been seen since.

As the project of testing evolved additional equipment and structures were installed to the present level, representing a considerable investment. During the years of testing some restricted diving was undertaken, for the purpose of maintenance and to set up equipment for the tests. Recreational diving has not been allowed since the D.R.C. has had control of the cave area, subsequently very little reliable information of the shape, size etc. of the underwater section was known prior to this study.

2 GEOLOGY

2.1 Introduction

Kilsbys Hole is a karst feature known as a 'cenote' – essentially a large inverse-conical collapse chamber in limestone that intersects the watertable giving rise to submerged passages. The classification 'cenote' is derived from similar geomorphological features in the Yucatan Peninsula of north-eastern Mexico, which together with the Mount Gambier area form the world's two most prominent cenote karst (limestone) fields. Other cenotes have been found in the southern Bahamas and on the central-western plateau of Turkey.

Location and Watertable

The dimensions of Kilsbys Hole are of the order of other cenotes on nearby properties in the Mount Schank area. Three large cenotes are found on Barnoolut Station two kilometres to the west, while three more are situated close together three kilometres south of the Kilsby property. Modern day watertable is remarkably flat in this region, and all sinkholes (cenotes) are located within the 10-8 metre contours of the underground water body (Figure 1).

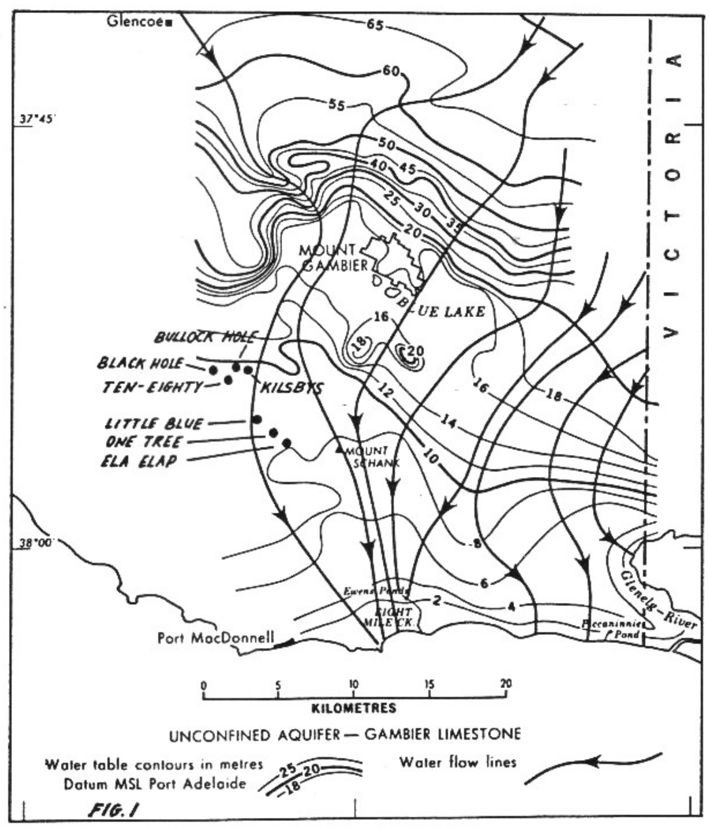


Figure 1. Map showing location of the large Mt. Gambier water-filled cenotes in relation to water table levels.

Theory of Formation

General theory of formation of these major sinkholes holds that during periods of lowered sea level during ice ages extending back to approximately 20 millions years, aggressive (slightly acidic) groundwaters dissolved extensive horizontal layers of limestone away to form massive 'spongework' mazes, which subsequently collapsed when the limestone could no longer support itself due to the voids within it. In no sinkholes, including Kilsbys Hole, have cave divers found any evidence of horizontal maze systems at any depths down to depths of 60 metres – the maximum depth that skilled air divers can attain with safety backup equipment. Notwithstanding, Kilsbys Hole is a limestone void occupying approximately 0.1 million cubic metres, and with much broken rock (talus) on the bottom of the hole throughout and the large exposed areas of the north-western and south-eastern walls (each approximately 2000 square metres) present a large area for water to attack and dissolve.

2.2 Geological Orientation and Control

Surveys of the surrounding cenotes by members of the Cave Divers Association of Australia have shown that all but one of the large cenotes are oriented parallel to the current shoreline. The exception is the sinkhole Ten Eighty which significantly is the second nearest to Kilsbys Hole. Most of the other known smaller caves of the Mount Gambier area (approximately 200 are known) also run northwest/southeast, which makes Kilsbys Hole all the more outstanding (Figure 2). Detailed surveying done by the CDAA Research Group show the familiar joint orientation occurring consistently throughout the hole, but in a subsidiary role. The dominant control in the formation of this sinkhole (or at least in its subsequent collapse) is what may be a major local fault line or large scale joint running the entire length of the south eastern wall, as shown in Figure 3. The existence of this pronounced feature is geomorphologically significant in an assessment of sinkhole genesis, and focuses attention on joint development in Ten Eighty sinkhole nearby. Another major joint was detected by survey accuracy – the joint running nearly north-south through the entrance hole and extending to the fossil site rift.

Figure 2. Plot of the orientation of the major fault features of the sinkholes in the Mt. Gambier region. Note that Ten Eighty and Kilsbys Hole are oriented differently to the other sinkholes.

Figure 3. Plan of Kilsbys Hole sowing the direction of the major fault line and regional joints.

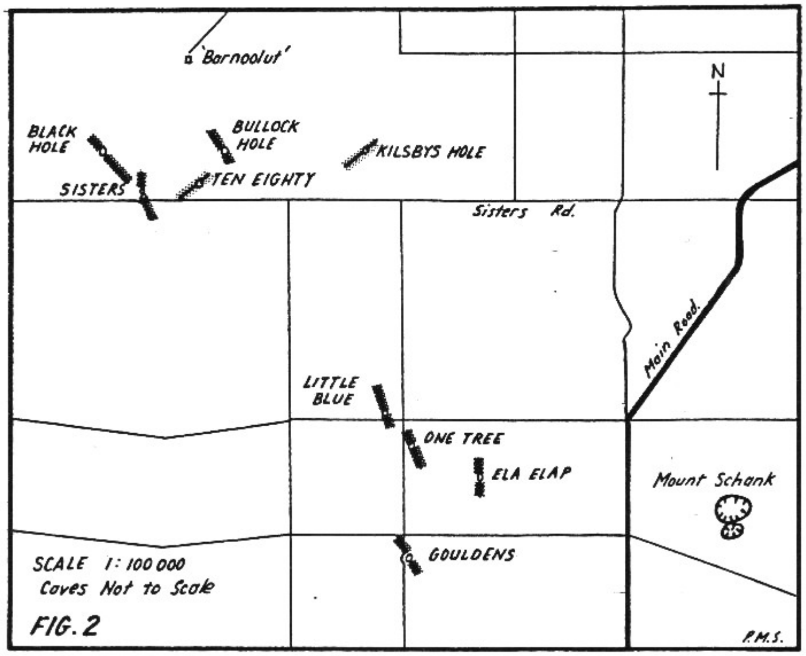

'Barnoolut'
N
BLACK HOLE
BULLOCK HOLE
KILSBYS HOLE
SISTERS
TEN EIGHTY
Sisters Rd.
Main Road.
LITTLE BLUE
ONE TREE
ELA ELAP
Mount Schank
GOULDENS
SCALE 1: 100 000
Caves Not to Scale
P.M.S.

FIG. 2

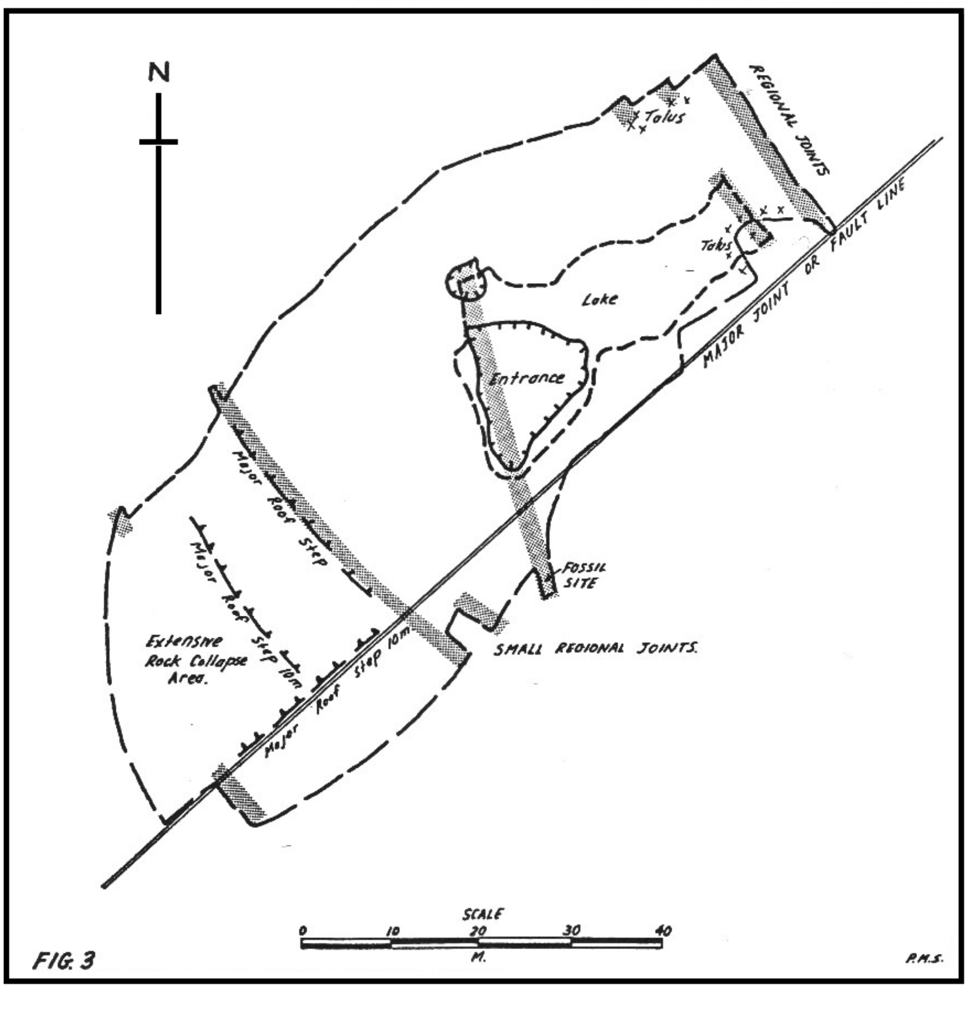

N
Talus
REGIONAL JOINTS
Talus
Lake
MAJOR JOINT OR FAULT LINE
Entrance
Major Roof Step
Major Roof Step 10m
Extensive Rock Collapse Area.
Major Roof Step 10m
FOSSIL SITE
SMALL REGIONAL JOINTS.
SCALE
0 10 20 30 40
M.
P.M.S.

FIG. 3

2.3 Other Features

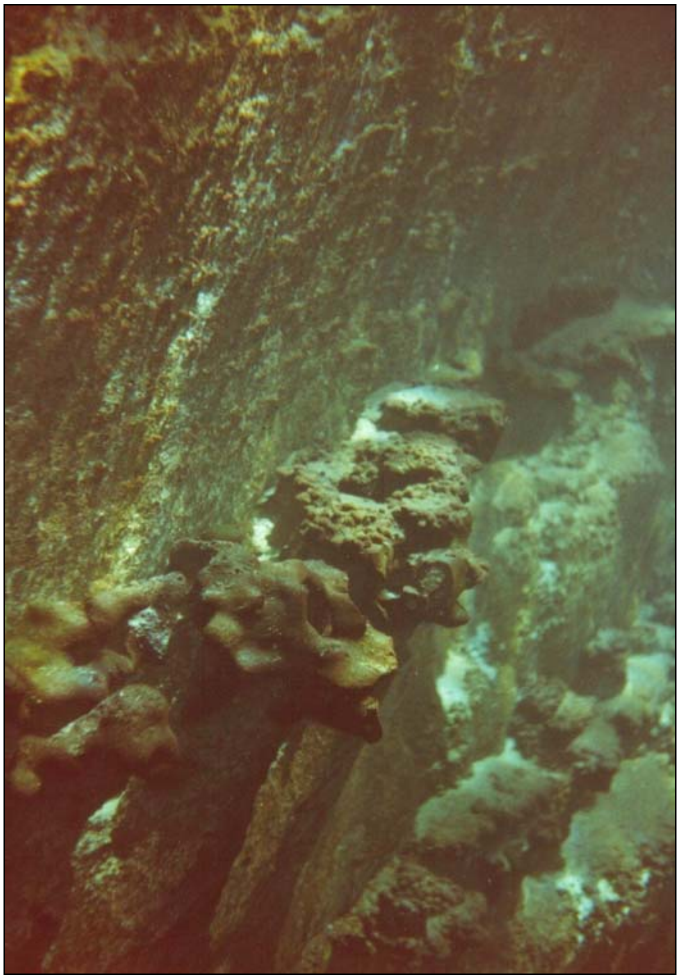
Notable along the wide exposure of walls were repeated bands of flints, variously spaced at approximately 5 metre intervals in the shallower part of the hole, but becoming more prevalent at greater depths (spacings usually 1 metre apart). (Photograph 2.2). Such bands may be associated with climatic changes during the deposition of the host rock. Some bedding plane collapse is associated with weaker flint band interfaces.

Sediment deposits of fine clays and some sand, and containing a sparse distribution of small rocks are collected in alcoves (Photograph 4) and small caverns down the length of the fossil site joint, and in the small cave on the mid north-western wall. Dating of these sediments may be arranged in the future to add to evidence collected by cave divers in all Mount Gambier sinkholes in aid of clarifying theories of the age of these features and their rate of collapse. It is expected that fossil dates will be considerably younger , maybe around 20,000 BP if other local fossil sites can be any guide.

Kilsbys Hole appears to be host to a range of phototrophic (light oriented) life forms observed in other sinkholes but yet to be described. Of particular interest in this sinkhole, however, was the observation of phototrophic forms growing on boulder talus across the bottom of the shallow mid-section of the hole (Photograph 5). Dating of these growths will enable for the first time an age of rock collapse to be obtained – at least a minimum age. Small samples of these biothems were collected for further study. On the whole, Kilsbys Hole gives the impression of being rather younger than the other large cenotes nearby.

2.4 Discussion

Kilsbys Hole presents the geomorphologist with several very interesting problems. The orientation pattern, possible fault-line origin, age and freshness of the feature, fossil discoveries, phototrophic time-indicating forms of life and extensive flint sequences all in the one location. Much further investigation backed by laboratory work can be conducted here if the opportunity arises.

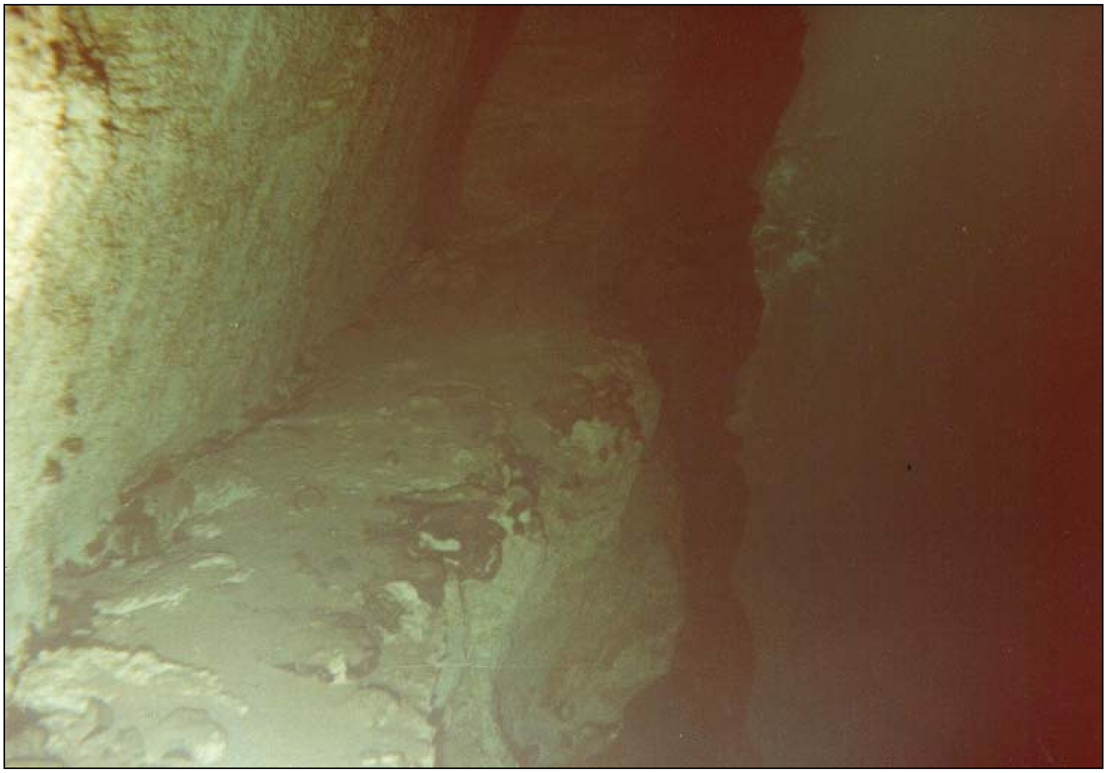


Photograph 2

Close view of horizontal flint band in SE area below entrance.

Photograph 3

Layers of flint bands at 10 m depth.



Photograph 4. Typical ledge with sediment deposits.

Photograph 5

Presumed phototrophic life forms on a boulder (15 m depth).

3 MAPPING

3.1 Introduction

Previous to this study, no details of the underwater section of Kilsbys Hole could be found. The only available sketches were from divers who visited the location some fifteen years ago and there was a large variability in opinion as to the size and depth of the sinkhole. Reports of depths between 180 to 300 feet were common, but there was no evidence to support these claims. Two of the divers on this expedition had visited the sinkhole in the early 1960's and provided the sketch map used for planning the diving and mapping activities. It was a major aim and the priority of this expedition to provide a good quality, accurate map of the underwater region of the sinkhole.

The above water section of this limestone feature has been studied and surveyed previously. A composite map of this region was obtained from two available maps – the Cave Exploration Group of S.A. (C.E.G.S.A.) (6) and the Department of Defence Plans of the surface including 3-inch contours, fences, and water surface on a one-metre grid. This latter plan appeared to be of registered survey accuracy. The map, plotted at a scale of 1:100, was used as a basis for the survey of the surface features.

3.2 Surface Survey

The surface survey was carried out using a fibreglass surveyors tape and a hand-held Suunto compass with an accuracy of +/- 0.5^{o}. The boundary fence surrounding the sinkhole was surveyed first and compared with the composite map. The buildings, platform, gantry and other major details of man-made structures were then plotted using right-angle offsets from the fence line or by bearing and distance from corner points. Our measurements corresponded with those available from the existing maps.

The natural features were surveyed next, again by offset or bearing and distance from known points. The shape of the two entrance holes was sketched between measured points such as corners or obvious features or changes in direction and can be expected to be accurate to 0.1 metre.

Points which were to be used as datum points for the underwater survey were then chosen and checked to ensure their correct position to eliminate carrying through any errors to the underwater survey. Datum points chosen on the surface were :

1) Centre of the trap door directly over the centre of the floating observation tower.
2) The bore.
3) The northern gantry guide which extends perpendicularly into the water.
4) A bolt secured in the lip of the south-eastern corner of the small window entrance.

All of these points are relocatable and were chosen to enable access to all the underwater sections.

Description of Surface Features

The basic shape of the opening is almost triangular, with its greatest dimension being about 15 metres across. A smaller, 3 metre diameter hole which lies just north of the western side of the main hole is a part of the main collapse, being separated by a thin bridge, or saddle, of limestone. The water depth under this hole is some 27m deep.

Many floating walkways and pontoons cover the surface of the crystal-clear water, and the submerged observation tower lies near the fixed entry ladder, on the southern side of the hole. A cleft or joint can be seen on the southern wall opposite the fixed ladder.

The walls above the water are coated with black, hard material. Where this has fallen away, the soft, white limestone beneath is exposed. It is quite unlike the better known sinkholes and cenotes in this regard.

Standing at water level, a tunnel can be seen in the northeastern wall, which travels in about 25m with a roof height 3m above the current water level. This tunnel is rectangular in shape, is 9m wide at the water's surface and has irregularly-shaped walls. A rockpile collapse is apparent at the back end of the tunnel on the south east wall. All of the limestone in the tunnel, apart from the roof, is very soft and crumbly and in some places (especially at the northwest corner) large boulders protrude from the wall.

The end wall of the tunnel is very straight, and its direction is approximately NW-SE, or 150^{o} magnetic. The roof itself is almost perfectly flat except where it approaches a bore pipe that has been inserted through the ceiling about 9m from the tunnel entrance.

The walls of the main sinkhole are quite contrasting; on the western side they are very smooth and almost vertical with little undercut to the water. There are also very few weathered cavities in the walls. On the eastern side however, the walls are heavily eroded and are far from smooth, sometimes only reaching the water after an obvious undercut.

Around all of the walls of the main collapse, at a height of about two metres above the present water level, there are many slit-like and dissolved features extending into the walls for up to 2 or 3 metres, possibly as a result of varying water table levels over many years.

The walls bell out considerably in the vicinity of the small 3m roof hole. The limestone surrounding the hole is quite thin and could be dislodged.

3.3 Underwater Survey

The main task of this expedition was to produce an underwater survey of Kilsbys cave of high standard and thus the success depended upon the organisation of the diving procedures.

Scuba Diving Organisation

The success of the underwater mapping depended upon efficient use of the limited time that could be spent underwater. It was known that the sinkhole was deep, of the order of 60 metres, and this presented special problems for the divers. After the initial orientation/exploratory dive, it became apparent that much of the mapping work would need to be done on dives with maximum depths of around 40 metres. Given the depths involved and that the water was quite cold, it was imperative to organise the diving so that it was carried out as safely as possible.

To this end, the diving was organised as follows:

i) only two dives per day below 10 metres for any diver.

ii) the deepest dive was to be undertaken first each day.

iii) the maximum surface interval between dives was arranged.

iv) a log of entry time, exit time, depth, bottom time, decompression and air consumption was kept for each person for every dive.

v) usual safe cave diving procedures were adhered to (for example dives were done in buddy pairs and the "one-third" rule was adhered to).

vi) all tasks to be completed on each dive were planned prior to entry into the water.

vii) two decompression lines with additional air supplies were located in the sinkhole in case they were needed.

Additional support systems for the diving were the on-site provision of scuba-filling compressors (provided by R. Garrad and J. Hiscock) and a backup compressor (P. Prust). A copper tube was connected to the compressor and lowered to the diving platform to allow scuba filling without removing the cylinders from the sinkhole.

An oxygen administration unit was provided by Dr. A. Swain of the Diving Medical Centre (Adelaide) for emergency use and first aid kits were supplied by the individual participants.

All the scuba diving equipment was the property of the individual participants except where otherwise indicated, and was at the minimum, that which is required for Category 3 diving (1).

Dive Profiles

On average, the first dive of the day was to 35m with 20 min. bottom time and 15 min. decompression. The surface interval was usually greater than 4 hours during which time results from the dives were plotted and analysed, scuba cylinder filling undertaken and the next dive's tasks worked out. The second dive was on average to 20m depth for 20 minutes with decompression of 20 minutes. Repetitive decompression calculations were the responsibility of the individuals but were always checked by another diver. The third dive of the day was kept as shallow as possible when undertaken.

During the two weekends a total of 71 dives were made during six days, of which all but 15 dealt directly with obtaining data for the underwater survey.

UNDERWATER MAPPING – Materials and Procedures

Materials

The following is a list of the materials used underwater to undertake the survey.

- 3 x 30 metre fibreglass survey tapes (measurements taken to 0.1m)
- approx. 1000 metres of 3mm twisted polyethylene floating line, marked at 10m or 5m intervals
- 6 x underwater compasses (underwater accuracy +/- 5^{o})
- underwater slates, pencils and 'wetnotes'
- depth gauges (readings taken to 1 metre, accuracy +/- 1%)

Procedures

Choice of Datum Lines and Points

An initial dive was carried out to ascertain the extent and depth of the cave and to decide where the first datum point and line should be placed.

An obvious right-angle section of the wall at the southwest corner of the long underwater tunnel was noted and chosen as the first datum point 'B'. The position of the point was relocated to the floor of the cave below this point when attempts to place a piton in the wall failed. The rock was too crumbly to hold the peg and so the new point was a rock on the bottom in the centre of the tunnel at 40 metres. The first datum line was thus laid between the bottom of the underwater observation tower and the centre of the tunnel which runs in a southeasterly direction from the tower.

To describe the dimensions of the tunnel the bearing of the datum line was taken, and the following measurements were made at the 10 metre marks on the laid line.

1) Depth of the mark.
2) Distance from line to roof.
3) Distance from line to floor.
4) Distance from line to each side of the tunnel at right angles to the line.

Initially, it was found that discrepancies in compass readings were about 25^{o} so these measurements were checked and rechecked until agreement of +/- 5% was obtained. The other measurements required two divers at any one time for each measurement. The roof measurements were carried out using a float attached to the end of a 30m tape, and for the bottom measurement from the line, a weight was attached to the end of the tape. It was found that the distance from the markers on the line to the western wall was too large for an accurate measurement to be made; however a rough idea of the width of the tunnel was obtained.

It took five dives to collect the above information along the first datum line. From these measurements it became evident that more datum points in the tunnel were necessary – the large size of the tunnel was beginning to be appreciated. Before the next datum points could be chosen, it was decided that more details of the end section of the tunnel were required. To this end, sketches of the area were made using (B) as a reference and taking compass bearings from major features in the area; in this way, the right-angled rock formation observed in the first dive was related to datum point B. It took a series of dives to obtain the data since the depth of this region was 30 to 40 metres.

Two more datum points were chosen following this work, A to the west of B, and C to the east and towards the deepest part of the cave. The remaining series of dives on the first weekend were used to concentrate on the shallower northeast section of the cave. The bore was chosen as the datum point from which a line was run to the walls. Similar measurements as described for the line from the observation tower to B were taken. As this part of the cave was shallow, the latter dives of the days were used for this work. By the end of the three days of diving, map plotting and surface surveying, a basic idea of the extent of the underwater section of the cave was known. The southwest corner was plotted and the details for the central longitudinal section were available. Many of the details of the above water wall were also located with respect to the underwater part and the surface survey.

The details obtained from the first weekend were transposed onto a new map (scale 1:100) as the basis for further details obtained on the second. The diving on the second weekend was more efficient than the first because of familiarity with the sinkhole and a clearer idea of the remaining tasks to be done.

Datum point A was connected to the bottom of the shotline located in the window entrance (north wall of the cave) by a line marked at 5 metre intervals. Roof heights, floor depths and distances from the western wall were measured as previously described. Datum points B and C were connected by tape, and B and A by line. Because of the depth of this cross-section (H-I) the details of this section (bearings and roof heights) took several dives of short duration to obtain. On the shallower dives, measurements for cross-section F-G (see Appendix C2) through the observation tower in a north-south direction were made. The southern point of this cross-section was chosen as the fossil bone site (Tag No. 6), thus allowing precise location of this site on the map.

As a detailed map of the major features of the underwater sinkhole was now becoming available, other interesting features and sketches of topography could be plotted. For example a hole in the western wall at roof height was found and plotted, and the air hole in the north-east corner of the cave was plotted also.

Description of the Underwater Cave

If the underwater section was to be viewed in a very simplistic form, from above, it would look like a rectangular area running north-east to south-west, and about 100m long by 35m wide with the south-west end rounded off. The main sinkhole entrance lies about 30m from the north-eastern end in the middle of the rectangle.

I The Main Sinkhole Opening

Nowhere beneath the main opening is the water shallower than 21m. The 21m area is the highest point of a steep mudpile slope, starting from the beginning of the air-tunnel on the north-east of the hole reaching a depth of some 27m at the south end, below the 21m-deep tower. The bottom is generally free of debris or boulders and consists of dark brown silt.

II The North-Eastern Air Tunnel Area

Swimming along the northeastern tunnel to its end, the bottom becomes shallower and more boulders become evident. Directly below the flat wall at the end of the air section, the water depth is around 11m. The bottom slopes from here to the entrance of the tunnel where it reaches 21m, the depth of the bottom below the main sinkhole opening.

Leaving the surface at the northeastern end of the tunnel, the walls do not drop straight to the bottom; about a metre below the water surface the walls drop back in a series of steps for a distance of 5 metres to a sheer vertical wall which is parallel to the flat wall visible above the surface at the end of the tunnel. This wall goes straight to the bottom. At the northwestern end of this wall, the bottom drops away steeply behind large boulders, to an easily-reached depth of 21m and probably continues for another 6m or so. Here, the end wall meets the western wall at a sharp angle approaching 90 degrees.

Although the air tunnel is only about 9m wide, the underwater section through the bore or at the end of the tunnel is around 25m or so.

At the eastern end of the end wall, a large boulder produces a tunnel section. Passing along this joint-like tunnel, calcite flakes drifted down, indicating the presence of an air-pocket, which is visible upon closer inspection at the end of a chimney-like tube in the roof along this fissure. The roof at this point is a huge rockpile jam which can be traversed to enter the air section of a small cave about 2m wide and 4m long and about 3m of air to the roof.

The walls of the underwater section of the northeastern tunnel are stepped with vertical rock slabs on both the west and eastern sides. The depth increases where the walls meet the bottom around many large boulders here and there. The vertical slabs run for large distances along the length of the tunnel; they are smooth and flat except where flint bands project about 20cm from the walls.

III The Main Underwater Chamber – South Western Aspect

The main cavern is a large area. It consists of a slightly sloping bottom with many large angular boulders and flat slabs of considerable size, some over 10 metres in length and 5 metres in height. Entering the cavern from the tower, the roof submerges to a depth of 3m below water level unlike most sinkholes where the walls are generally slightly inward-sloping for tens of metres before they bell out. The roof is not domes shaped in this sinkhole; it is very angular and its depth varies across its width, sometimes by up to 10m. When depth or height changes occur, they are usually abrupt, like steps. Along the length of the main tunnel, the bottom was on average 20m below the roof. When swimming along the roof, the bottom and the sides of the sinkhole were visible to the diver because of the excellent visibility of the water.

At various places in the main tunnel, the walls of the sinkhole exhibit joint features. The most obvious one is 40m along the tunnel at a depth of 30m where a false roof on the south side meets the western wall at a very acute angle. Beyond this, the roof becomes the end wall of the cave as it drops in large angular slabs towards the bottom. The floor meets the wall at the southern and western aspect, but in the southeastern aspect the wall outlines the deep section of the cave where the bottom and wall meet at some 60m depth (refer to cross-section H-I for the shape of this part, Appendix C2). In the deep section, large boulders lie in a jumble close to the wall to form a narrow section that is almost vertical. The walls on either side of the tunnel are generally sheer and roughly vertical between the rood and bottom. It is a bit like swimming along irregularly spaced steps that have been placed on their side; the walls are not generally stepped from roof to floor but from beginning to end of the tunnel.

Exiting from the cavern along the north west wall, at a depth of 21m, is a small split cave feature of triangular shape running into the wall for about 5m. It is barely big enough to enter, being about 1.5m wide by 2m high at the apex.

This feature is 32m into the cavern along the north west wall from the window entry to the sinkhole.

Another interesting feature in the tunnel is the fissure on the southeastern wall that appears to be the underwater extension of the fissure visible on the surface to the southeast of the fixed ladder from the platform in front of the shed. It is in this fissure at depths of 15 and 20m that fossils were located on ledges.

3.4 The Map

The result of this survey was a map of the underwater section of Kilsbys Hole (L46) of cave survey standard Grade 4 (2) and is shown in Appendix C. This is probably the highest standard that is possible to obtain given the constraints of being underwater and using the basic materials available. The final plan was photo reduced to 1:200, the scale recommended by the Australian Speleological Federation (2). Where possible, symbols and notation of the Australian Speleological Federation Cave Survey and Map Standards were used; however, as has been found previously, these symbols are not always suitable for the description of underwater features. Thus some departure from the standard was necessary.

It was considered that sufficient bottom depths had been obtained to interpolate bottom contours. This is the first time this has been carried out by us or anyone else to our knowledge on the sinkholes in the Mt. Gambier region and the result is shown in Appendix C1. Whilst these contours can only be considered as a guide, they add a third dimension to the plan. In conjunction with the plan map, the major features of the sinkholes are described well by the cross-sections. Section F-G, running north-south through the sinkhole visible from the surface, describes the cave depth and shape that can be viewed by the visitor. Section D-E describes the shape of the tunnel leading from the open surface to the north-east. Section X-Y shows the shape of the sinkhole through its maximum extent, from the tunnel in the northwest to the main underwater tunnel in the southwest. Finally, section H-I shows the deepest part of the cave, found at the end of the southeast tunnel.

3.5 Discussion

Generally the equipment and techniques used were satisfactory for obtaining the standard of map produced. The major limitation is the amount of time that could be spent underwater to carry out the mapping tasks. From this point of view, it would have perhaps been better to have had more divers to assist with the project given the limited access and short diving times. Prior knowledge of the underwater section of the cave would have assisted somewhat as time spent in orientation detracted from the overall time that could be spent on the survey. For the same reason, there are still a number of features of the cave which we now recognise as being significantly different from other sinkholes in the Mt. Gambier region but which we have insufficient detail to make major conclusions.

4 HYDROGRAPHY

Water temperature profiles have been carried out in some of the sinkholes of the Mt. Gambier region over the last couple of years. Some of these results have been reported previously (3) and hence the group had a good opportunity to compare Kilsbys Hole with the other known sinkholes in this region. In addition to measuring water temperatures at various depths, water samples were collected at several locations and at various depths for further laboratory analysis. Basic water characteristics of conductivity, pH and quantity of dissolved oxygen were also measured in the sinkhole. Results from these studies can be compared with available information obtained from other sinkholes.

4.1 Water Temperature Measurements

Methods

Temperatures were taken using a check-calibrated mercury thermometer accurate to +/- 0.2°C. Temperatures were taken at the surface, in the sun and in the shade, and at 3m depth intervals in the open part of the sinkhole, and in the long tunnel.

Results

At the surface, the temperature was recorded at 17.0°C in the sunlit areas, and 16.2°C in the shade. Leaving the surface, a reading was taken at one metre depth and was found to be 15.8°C. All further readings at 3m intervals to a depth of 39m did not vary from this figure.

Discussion

From the results, it can be seen that there is a small variation between the temperatures of the surface water (16°C) and the water below one metre in depth (15.8°C); however, the difference is not significant. At any depth or location below one metre the water temperature was uniform. Generally, the other sinkholes in the Mount Gambier region have definite temperature layers at this time of the year (Fig. 4), with relatively warm masses overlying colder and clearer water. These sinkholes have large surface areas exposed to direct sunlight, which apparently promotes algae growth in the warmer layer. Kilsbys Hole is different in this regard, having no suspended algae or variations in temperature.

The other known feature with similar characteristics is the 'Bullock Hole' on the neighbouring property, 'Barnoolut', which also has a relatively small opening with most of the lake surface being in permanent shadow. It is speculated that as the algae grows, it traps heat which then contributes to further algae growth to eventually produce a layer of warm murky water during the summer months.

Previous studies have shown that the situation is reversed during the winter months; the surface layer of algae disappears leaving clear, colder water of the same temperature as the water below. Underwater visibility usually decreases with depth due to the presence of very fine suspended matter which could be the dead algae formed during the previous summer.

Kilsbys Hole and the Bullock Hole do not follow this pattern, because algae growth cannot form due to lack of direct sunlight. Consequently, the water is clear throughout the year at all depths and remains at a constant temperature. A similar study of possible changes in the water temperature at depth and observations of visibility variations in Kilsbys Hole would be of value if done in the colder months of late winter.

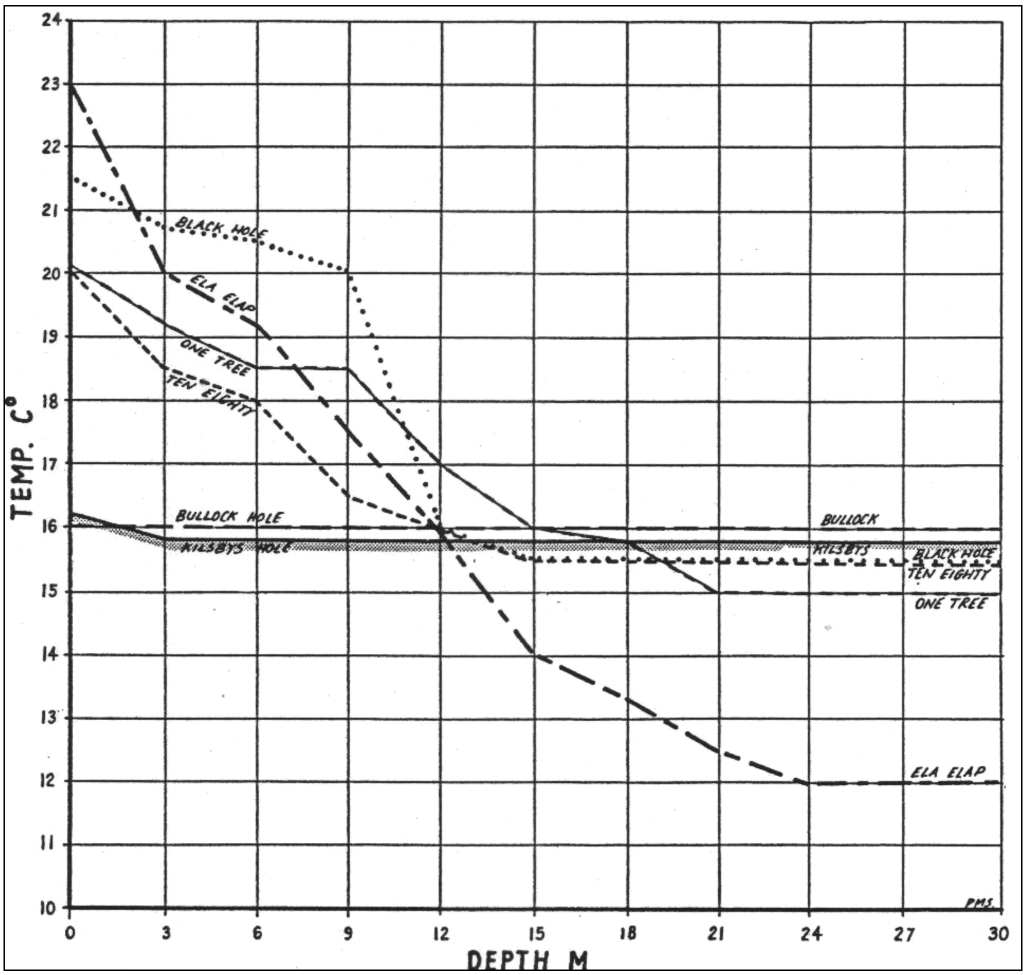


Figure 4
Graph comparing water temperature profiles at 5 locations taken in Feb-Mar 1982 with Kilsbys Hole in February 1983.

4.2 Water Chemistry

Methods

Conductivity, pH and dissolved oxygen qualities of the water were measured on site at the surface by the divers platform in the northwest corner of the lake using portable scientific water analysis equipment. Several samples of the water were collected at the surface, at 15m below the bore and at 45m at datum point C in the southeast corner of the cave. They were collected in two litre sample bottles and were taken to the EWS State Water Laboratories for analysis. To take samples below the water surface, it was necessary to carry the sample bottles filled with water to the sample site to prevent implosion. To remove the unwanted water, an air jet was used and then the bottle was refilled with the water from that location. This system was effective at all depths sampled.

Results

Water samples were collected from various depths and locations throughout Kilsbys Hole and analysed. A summary of the results of chemical analysis are given in Appendix A which also provides data on sinkholes in close proximity available from published material for comparison. Although water samples were taken from various locations within the sinkhole, no significant difference between the water in the various locations was found (details of all samples in Appendix A). The items of special interest were:

Dissolved salts :- 383 mg/l	This is average and is slightly more than the Blue Lake (370) and less than Eight Mile Creek (496)
PH = 7.5	The laboratory results support the field test of 7.6. This water is slightly alkaline for the area.
Colour = 1.0	This is a very low reading indicating that the water is very clear.
Turbidity = 0.2	This is very low also; the turbidity of the Murray R. is 14.
Oxidised Nitrogen = 3.91 mg/l = 17.32 NO_3	Range for the area is from 0-200 NO_3.
Total Organic Carbon = 2.0 mg/l	This together with NO_3 levels gives a good indication of nutrient pollution levels. South East ranges from 0-10 and higher and thus this location appears relatively unpolluted.
Total Hardness = 250mg/l	This is typical of South East water which is reasonably hard due to calcium from the limestone. By comparison, Adelaide water is 100mg/l.

Suspended Solids = 1.0mg/l	This is very low as would be expected in this situation. It shows that no silt or foreign matter entered the sample bottles as can occur in other deep water sampling methods.

The characteristics of Kilsbys Hole compare favourably with published data on Bullock Hole, a sinkhole in close proximity with a small surface area that is exposed to sunlight (Appendix A6).

4.3 Water Level

At the time of this study, the water level was 13.57m on the staff gauge situated in the south east section of the lake. The datum of this gauge is not known, however it coincides closely with Australian Height Datum.

Variation in the water level of this sinkhole is affected by local factors in addition to hydrogeological, as regular pumping from the sinkhole is carried out by the landowner. A pump of 20,000 – 30,000 gallons/hr (90,000 to 140,000 litres/hr) capacity is located in the northwest extension of the cave and is utilized 8-10 hours per day for 7-day periods to provide water for irrigation.

It is not known whether the measured level reflects the recent pumping history or the hydrogeological level of the water table at the sinkhole.

4.4 Discussion

Whilst the results of water temperature measurements and water quality analysis taken during this study are significant in several respects, we can only speculate at the overall water characteristics of this feature. Further measurements and sampling would be required through the range of seasonal changes in conjunction with algae and other biological studies at this site and other sinkholes before any firm conclusions can be made.

5 PALAEONTOLOGY

5.1 Introduction

The freshwater-filled sinkholes of the Mt. Gambier region have proved to be an ideal environment for the preservation of fossil bones in some cases. The Fossil Cave alongside the Millicent-Mt. Gambier road has yielded the skeletons of extinct kangaroos in excellent preservation condition and in one case, nearly all of the bones of an individual were found articulated. Material from other extinct marsupials was also found and in larger quantities than from which the identifications were originally made. Thus, at least one sinkhole in the region has shown to contain a capsule of time that is valuable for the understanding of our fossil history (Appendix B).

Kilsbys Hole has a history of bone collection. During the period the sinkhole was used as a testing site, some bone material was collected. To the best of our knowledge, it was collected from the direct 'fall' zone. We are unaware as to where this material was taken and whether or not it was identified. As a relatively undisturbed sinkhole and evidence that fossil bone material may have been taken from the site previously, the sinkhole was worth investigating.

5.2 Methodology

There are four phases to the collection of fossil bones, whether it be in a sinkhole as on this occasion or anywhere on land. The major difference between underwater fossil sites and land sites is that it is not possible to dissect sites with the same detail in the underwater environment because of the enormous amount of time that this would take.

The four phases are:

1) Location of site
2) Collection of sample of material (tooth or jaw)
3) If material is important, photograph site, measure, grid etc.
4) Careful collection and recording of material.

1) Site Location

The location of sites of fossil bones entailed swimming about the sinkhole, keeping a lookout for indications of bone material. Locating and searching ledges was one step and ledges outside of the direct surface were thought to be the most promising places to find fossil from extinct animals.

2) Collection of Samples

In the event of finding material, two cages were taken that had been made by the School of Biological Sciences at Flinders University specially for carrying bones through water. The cages were made of mesh and had a layer of fine bronze mesh inside to catch the fragments of bones.

5.3 Results

Fossil Sites

On the first weekend there was little time spent searching for bone material; however we did find one likely site. A crack extends in a southeasterly direction adjacent to the underwater tower; it is continuous from the surface to the bottom. At depths of 18m and 21m, there are two ledges in the crack, one above the other. We observed bone material on both of these ledges. Both sites are not in the direct 'fall' zone of the current water surface (see maps Appendix C).

On the second weekend we spent another whole dive inspecting the shallow water which is in the 'fall' zone. There is a large amount of bone material in several places; much of it very small and probably bird material. We did not find another area that was as promising as the site found on the first weekend and labelled Site 6.

Sample Collection

On the first weekend, a single tooth was collected from Site 6. This has since been identified as the right incisor of the marsupial lion 'Thylacoleo' which is extinct. On the second weekend, we collected a sample of other bone material from Site 6 and delivered them to Flinders University where they have been preserved and are awaiting the return of Dr. R.T. Wells who is on a field trip for their identification. There is a good possibility that this material is from extinct animals because it was found along with the 'Thylacoleo' tooth.

Other bone material was collected on the second weekend from the bottom, underneath the 'fall' zone. We have no idea of the status of these bones but it is quite likely that this material is of recent origin.

Site Description

Photographs were taken of Site 6 but were not of sufficient quality to be of use in describing the area. Another visit to the location would be necessary to do this and dives made specifically for photography need to be made. The dimensions of the site have yet to be measured also.

Condition of Bone Material

The preservation of the bone material is good. This is typical of the material that has been found in other sinkholes, in particular Fossil Cave, and is the reason that the material is so sought after. The bone is not crumbly and can be collected safely without damage if sufficient care is taken. Some of the material on the bottom ledge of Site 6 is broken due to rocks falling on to it from the ledge above.

Below is a photograph of some of the material collected as it dried in the sun prior to packaging for transportation to Adelaide.

Photograph 6. A collection of bones from Site 6.

5.4 Discussion

Any further comments on the importance of the find must await the identification of the material already collected.

6 BIOLOGY

During the dives free from mapping duties, a limited amount of biological collection and observation was carried out.

The surface of the water was covered with a fine dust layer upon arrival, but was free of any duckweed that has been observed in other sinkholes. In the past (early 1960's)m duckweed was frequently seen on the surface (personal communication with Mrs. Kilsby). There were no floating 'platforms' of any plant or algae present during the study period.

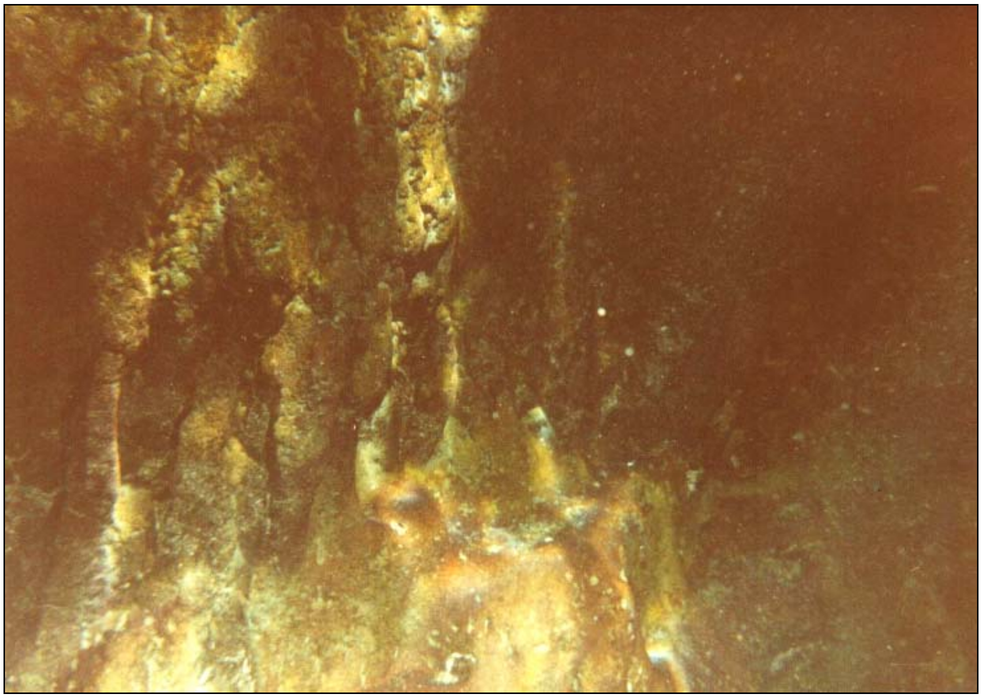
Beneath the water surface, in the initial 5-6 metres depth, various green and brown algae were evident (Photograph 7). Plant growth mainly consisted of filamentous mats on ledges (Photographs 8 and 9). No samples were taken as we have yet to establish contact with a scientist who has special knowledge of freshwater algae.

Particular attention was paid to searching for freshwater crustacea and sponges, which have been the subject of study in other sinkholes. In 1981, Peter Horne of the expedition group collected specimens from Fossil Cave (5L81) which were identified by Wolfgang Zeidler (Curator of Marine Invertebrates at the S.A. Museum) as syncarids; a rare and previously undescribed species of *Koonunga*, the discovery of which has aroused considerable scientific interest. (4)

On this occasion, 16 specimens were collected; 14 females and 2 males. Although it is not known what proportion of the population was collected or whether there was an unknown bias in the collection procedure, it is interesting to note that this ration of male to female is similar to that obtained from the same random technique used in collections from other caves. Most of the syncarids were taken from the walls of the sinkhole at 3m depth where they were in abundance, especially in the shade. Only one specimen was seen in mid-water near the centre of the hole. Two individuals were collected at 30m depth and all have been officially logged with the S.A. Museum.

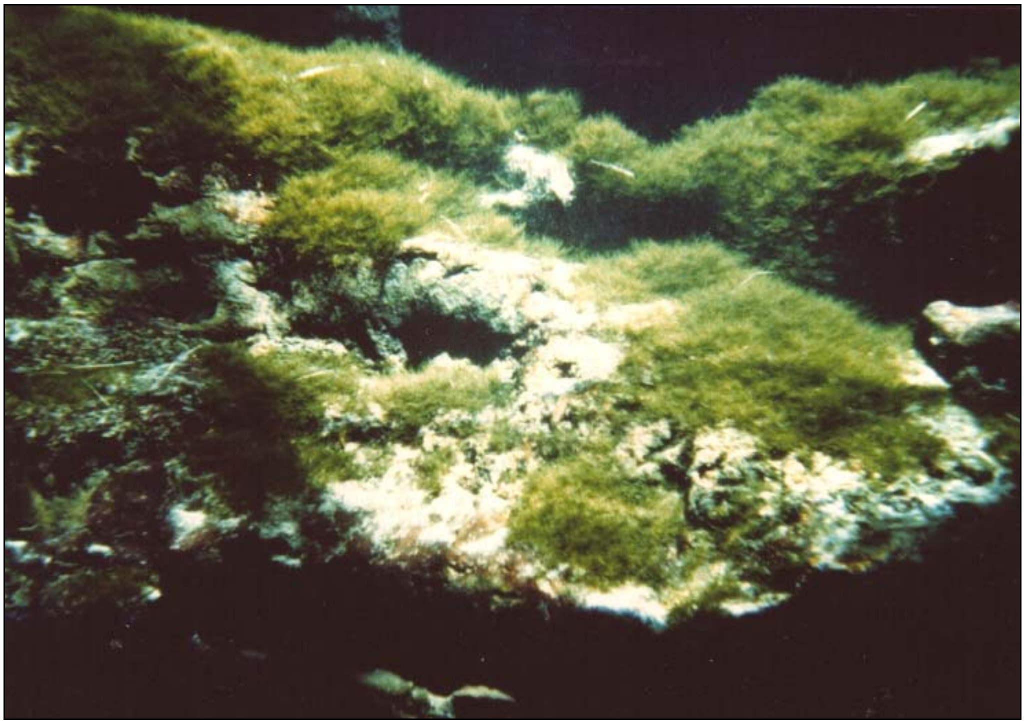
Common forms of life observed included very large tadpoles, frogs (Photograph 10), yabbies on the silty floor and mayfly nymphs (probably *Atalophlebia australasica*) which are common in other sinkholes at shallow depths. No freshwater crayfish, sponges or fish of any kind were sighted.

Kilsbys Hole is one of the few remaining sites known where fairly rare forms of life abound, probably due to the lack of unnatural interference caused when mankind introduces creatures into areas where the natives become the prey. The syncarids are thought to be especially vulnerable to minute changes in water conditions, and the abundant populations indicate that despite whatever has occurred here, there has been little interference with the underwater ecology of the hole – an achievement which is felt to be commendable in view of the size of the installation. It is hoped that the hole will remain free of introduced species or contaminants in the future as well.

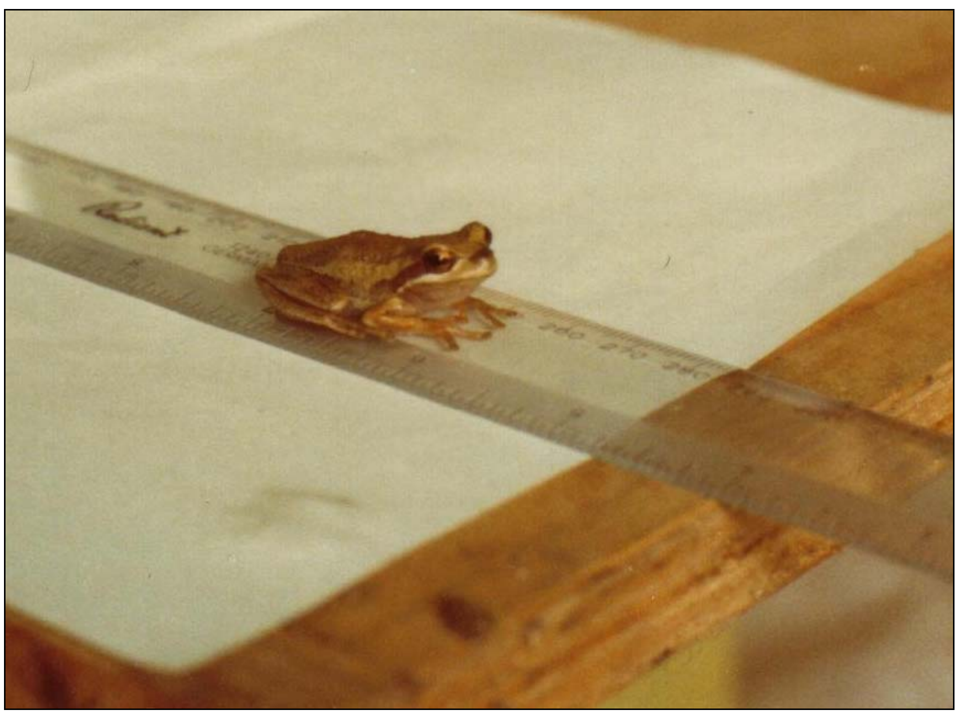


Photograph 7. Green brown algae found on walls in N.W. corner of cave entrance area.

Photograph 8. Filamentous mat plants also in the N.W. sector.



Photograph 9.   Filamentous mat plants.



Photograph 10.   Frog captured below entrance.

7 SEDIMENTOLOGY

7.1 Silt Sampling

A large jar of light brown, 'flecky' looking silt was collected from the surface of the collapse zone at 26m directly beneath the Observation Tower (Figure 5). When disturbed, the silt was noted to settle very quickly in comparison to silt encountered in many other local sinkholes.

This sample was tested by Dr. Vic Gostin, a Sedimentologist at Adelaide University who obtained the following results:

86% : sand sized materials (above 63 microns)
12% : silt (unidentified, 7-63 microns)
2% : clay (1-7 microns) consisting of quartz, calcite and traces of kaolinite.

Optical study of the sand-sized material showed it to be non-crystalline and made up of 90% ash or sinter, a very large percentage in terms of natural deposition. Further study could possibly show it to be volcanic ash from the relatively recent nearby cones of Mt. Schank or Mt. Gambier and such information could assist in dating various details in the cave, e.g. a minimum date of the opening forming. Of the remaining 10%, approximately 2% was charcoal, 2% quartz, 2% fibrous organic material and 4% shell and bryozoa debris.

To be able to use these results with any certainty, more information is required in the form of properly-positioned core samples of the deeper bottom sediments (see Figure 5). These would be very valuable in adding to our understanding of time sequence and formation of this sinkhole.

7.2 Other Studies

In addition to the taking of a silt sample, two long-term experiments were initiated by the complete clearing-back to base rock of two ledges (Photograph 11) for the study of silt accumulation and the growth of phototrophic features described in Section 2.3.

The silt accumulation study site is situated in 5m of water adjacent to the gantry leg in the south-southeast corner of the lake (Figure 5). The growth study site is further northeast along the same wall just inside the entrance to the air tunnel, and is in 3m of water (Figure 5). Both ledges have been marked with bright pink tags, visible from above the surface, and were photographed after clearing (Photographs 12 and 13).

It is hoped that at some time in the future these sites can be reexamined to establish if changes have occurred. Placement of plastic sheeting on a further ledge would, it is expected, give more accurate results for silt accumulation and would be installed if the opportunity arises.

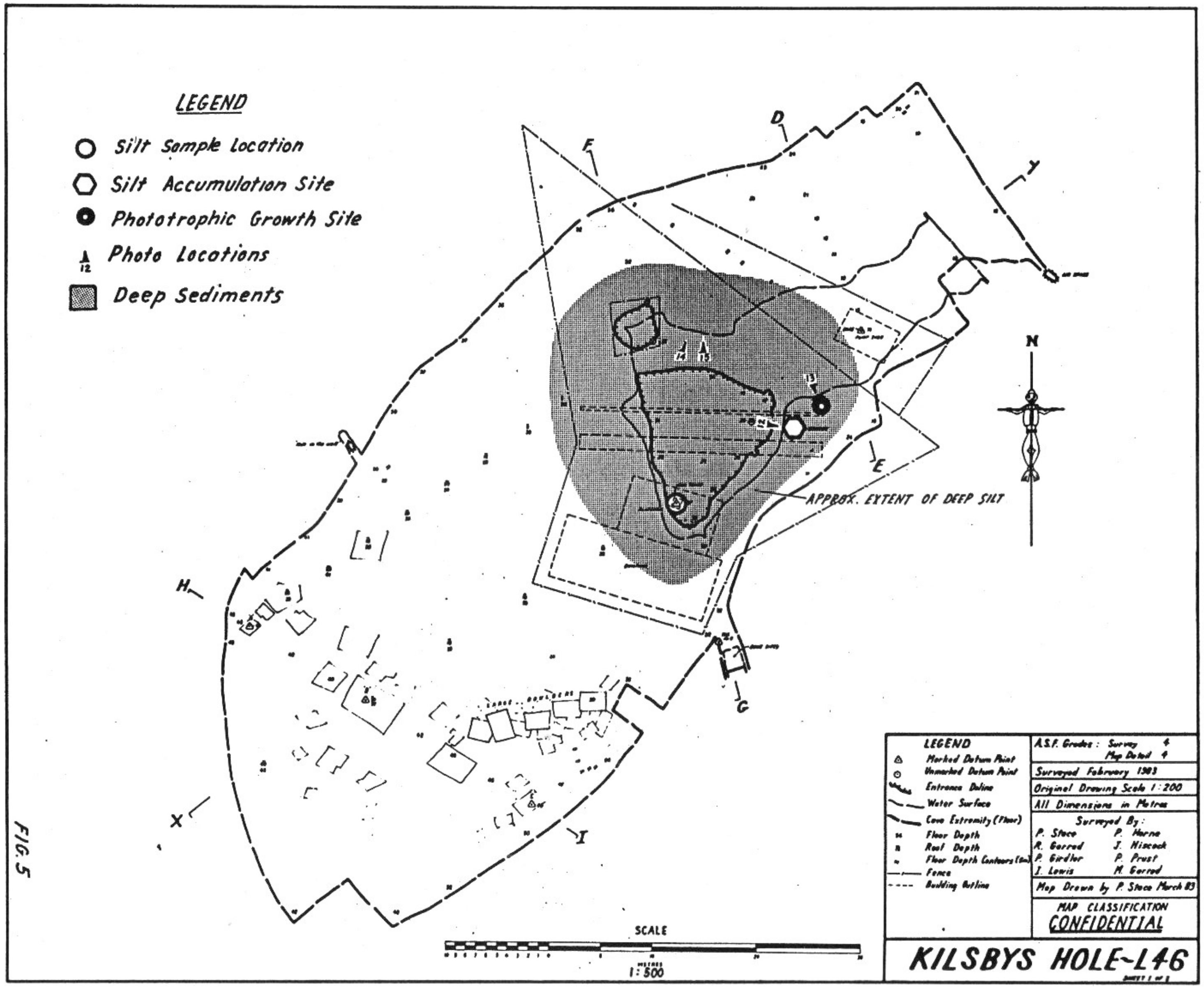

LEGEND
Silt Sample Location
Silt Accumulation Site
Phototrophic Growth Site
Photo Locations
Deep Sediments
APPROX. EXTENT OF DEEP SILT
N
SCALE
1:500
LEGEND
Marked Datum Point
Unmarked Datum Point
Entrance Doline
Water Surface
Cave Extremity (Floor)
Floor Depth
Roof Depth
Floor Depth Contours
Fence
Building Outline
A.S.F. Grades: Survey 4
Map Detail 4
Surveyed February 1983
Original Drawing Scale 1:200
All Dimensions in Metres
Surveyed By:
P. Stace P. Horne
R. Garrod J. Hiscock
P. Girdler P. Prust
J. Lewis M. Garrod
Map Drawn by P. Stace March 83
MAP CLASSIFICATION
CONFIDENTIAL
KILSBYS HOLE-L46

FIG. 5

Photograph 11

Clearing ledges.

Photograph 12

Silt site.

Photograph 13

Growth site.

Another unique feature of this sinkhole is the existence of a hard skin of brown material covering parts of the walls, especially in the shadows on the northwest sector below the entrance (Figure 5). In some areas this skin has broken away forming abstract lace-like patterns exposing the soft white limestone beneath (Photographs 14 and 15). In the waterfilled gap between this skin and the base rock, numerous small creatures were to be found (Section 6).

Samples of this hard yet fragile skin were analysed chemically and with an electron microscope by Mr. John Terlett of the Defence Research Centre and were found to be almost entirely calcium carbonate. The process by which this skin forms, and its distribution within the cave, are not known and further investigations are required.

Photograph 14.	Photograph 15.
Dark calcite layering above soft white limestone in small cavity.	View of cavity from 4m away, about 3m deep in the northwest sector.

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STATE WATER LABORATORIES

WATER ANALYSIS REPORT

APPENDIX A1

LOCATION : 1195 - CAVE L46 - SURFACE SAMPLE
DESTINATION : SENCHEM WOA   DEBIT NUMBER : 3000
SAMPLING DATE : 6. 2.83   TIME : 930   MULTIPLICITY : 0
LAB REF : 1289   TIME UNITS : 504

REMARKS

* Recommended storage time exceeded & on receipt

CERTIFIED AS CORRECT : ____________
SENIOR CHEMIST

CODE	DESCRIPTION		VALUE
GENERAL DATA			
4211	DISSOLVED SALTS-CALC (MG/L)		383.
4015	TDS-TOTAL DISS. SALTS (MG/L)		374.
4016	CONDUCTIVITY @ 25C (US/CM)		681.
4010	PH		7.5
4207	FREE CARBON DIOXIDE (MG/L)		14.
4101	ALKALINITY-CACO3 (MG/L)		235.
4017	COLOUR-TRUE @ 395NM (HAZEN)		1.
4018	TURBIDITY (NTU)		0.2
4022	DETERGENT (MG/L)		0.02
4019	GAUGE HEIGHT (M)		[illegible]
NUTRIENTS			
4109	PHOSPHATE-P,TOTAL (UG/L)		7.
4108	PHOSPHATE-P,SOL (UG/L)	<	5.
4161	OXIDISED NITROGEN-N (MG/L)		3.91 = 17.32 NO_3
4106	NITRATE-N (MG/L)		3.91
4107	NITRITE-N (MG/L)	<	0.01
4100	AMMONIA-N (UG/L)	*	-99.
4112	TKN-N (MG/L)		0.16
4111	SILICA,REACTIVE (MG/L)		11.
4158	TOTAL ORGANIC CARBON (MG/L)		2.
CATIONS			
4520	CALCIUM (MG/L)		82.
4555	MAGNESIUM (MG/L)		11.
4600	SODIUM (MG/L)		43.
4580	POTASSIUM (MG/L)		1.2
ANIONS			
4103	CARBONATE (MG/L)		0.

/2

4101	BICARBONATE (MG/L)		287.
4110	SULPHATE (MG/L)		13.
4104	CHLORIDE (MG/L)		64.
4105	FLUORIDE (MG/L)		0.18

HARDNESS

4203	CARBONATE HARD.-CACO3 (MG/L)		235.
4204	NONCARB. HARD.-CACO3 (MG/L)		15.
4205	CALCIUM HARD.-CACO3 (MG/L)		205.
4206	MAGNESIUM HARD.-CACO3 (MG/L)		45.
4202	TOTAL HARDNESS-CACO3 (MG/L)		250.

HEAVY METALS

4515	BORON,TOTAL (MG/L)		0.03
4545	IRON,TOTAL (MG/L)	<	0.005

DERIVED DATA

4201	SODIUM ADSORPTION RATIO		1.2
4209	SODIUM/TOTAL CATIONS (%)		27.1
4208	TOTAL CHLORIDES-NACL (MG/L)		105.
4200	LANGELIER INDEX		0.25
4210	ION BALANCE (%)		-1.21

OTHER DATA

4160	SUSPENDED SOLIDS (MG/L)		1.

MANAGER STATE WATER LABORATORIES

NOTE - DETERMINATIONS WITH COMMENTS ARE FLAGGED WITH *

STATE WATER LABORATORIES

WATER ANALYSIS REPORT

APPENDIX A2

LOCATION : 1195 - CAVE L46 - 15M DEPTH
DESTINATION : SENCHEM WQA — DEBIT NUMBER : 3000
SAMPLING DATE : 6. 2.93 — TIME : 1400 — MULTIPLICITY : 0
LAB REF : 1290 — TIME UNITS : 504

REMARKS — * Recommended storage time exceeded on receipt

CERTIFIED AS CORRECT : ______________
SENIOR CHEMIST

CODE	DESCRIPTION		VALUE	
	GENERAL DATA			
4211	DISSOLVED SALTS-CALC (MG/L)		377.	
4015	TDS-TOTAL DISS. SALTS (MG/L)		375.	
4016	CONDUCTIVITY @ 25C (US/CM)		682.	
4010	PH		7.6	
4207	FREE CARBON DIOXIDE (MG/L)		11.	
4101	ALKALINITY-CACO3 (MG/L)		235.	
4017	COLOUR-TRUE @ 395NM (HAZEN)		1.	
4018	TURBIDITY (NTU)		0.3	
4022	DETERGENT (MG/L)		0.02	
4019	GAUGE HEIGHT (M)			
	NUTRIENTS			
4109	PHOSPHATE-P,TOTAL (UG/L)		7.	
4108	PHOSPHATE-P,SOL (UG/L)	<	5.	
4161	OXIDISED NITROGEN-N (MG/L)		3.91	= 17.32 NO_3
4106	NITRATE-N (MG/L)		3.91	
4107	NITRITE-N (MG/L)	<	0.01	
4100	AMMONIA-N (UG/L)	*	-99.	
4112	TKN-N (MG/L)		0.19	
4111	SILICA,REACTIVE (MG/L)		11.	
4158	TOTAL ORGANIC CARBON (MG/L)		5.	
	CATIONS			
4520	CALCIUM (MG/L)		83.	
4555	MAGNESIUM (MG/L)		11.	
4600	SODIUM (MG/L)		41.	
4580	POTASSIUM (MG/L)		1.2	
	ANIONS			
4103	CARBONATE (MG/L)		0.	

/2

4102	BICARBONATE (MG/L)	287.
4110	SULFATE (MG/L)	10.
4104	CHLORIDE (MG/L)	62.
4105	FLUORIDE (MG/L)	0.15

HARDNESS

4203	CARBONATE HARD.-CACO3 (MG/L)	235.
4204	NONCARB. HARD.-CACO3 (MG/L)	17.
4205	CALCIUM HARD.-CACO3 (MG/L)	207.
4206	MAGNESIUM HARD.-CACO3 (MG/L)	45.
4202	TOTAL HARDNESS-CACO3 (MG/L)	253.

HEAVY METALS

4515	BORON,TOTAL (MG/L)	0.03
4545	IRON,TOTAL (MG/L)	0.007

DERIVED DATA

4201	SODIUM ADSORPTION RATIO	1.1
4209	SODIUM/TOTAL CATIONS (%)	26.0
4208	TOTAL CHLORIDES-NACL (MG/L)	102.
4200	LANGELIER INDEX	0.36
4210	ION BALANCE (%)	-0.63

OTHER DATA

4160	SUSPENDED SOLIDS (MG/L)	2.

MANAGER STATE WATER LABORATORIES

NOTE - DETERMINATIONS WITH COMMENTS ARE FLAGGED WITH *

STATE WATER LABORATORIES

WATER ANALYSIS REPORT

APPENDIX A.3.

LOCATION : 1393 - CAVE L46 - 45M DEPTH
DESTINATION : SEN CHEM WQA DEBIT NUMBER : 3000
SAMPLING DATE : 13. 2.83 TIME : 1100 MULTIPLICITY : 0
LAB REF : 1372 TIME UNITS : 504

REMARKS

CERTIFIED AS CORRECT : ____________
SENIOR CHEMIST

CODE	DESCRIPTION		VALUE	
GENERAL DATA				
4211	DISSOLVED SALTS-CALC (MG/L)		382.	
4015	TDS-TOTAL DISS. SALTS (MG/L)		370.	
4016	CONDUCTIVITY @ 25C (US/CM)		673.	
4010	PH		7.4	
4207	FREE CARBON DIOXIDE (MG/L)		17.	
4101	ALKALINITY-CACO3 (MG/L)		220.	
4017	COLOUR-TRUE @ 395NM (HAZEN)		1.	
4018	TURBIDITY (NTU)		0.2	
4022	DETERGENT (MG/L)		0.04	
NUTRIENTS				
4109	PHOSPHATE-P,TOTAL (UG/L)	<	5.	
4108	PHOSPHATE-P,SOL (UG/L)	<	5.	
4161	OXIDISED NITROGEN-N (MG/L)		3.85	= 17.06 NO_3.
4106	NITRATE-N (MG/L)		3.85	
4107	NITRITE-N (MG/L)	<	0.01	
4100	AMMONIA-N (UG/L)		6.	
4112	TKN-N (MG/L)		0.24	
4111	SILICA,REACTIVE (MG/L)		11.	
4158	TOTAL ORGANIC CARBON (MG/L)		3.	
CATIONS				
4520	CALCIUM (MG/L)		78.	
4555	MAGNESIUM (MG/L)		12.	
4600	SODIUM (MG/L)		49.	
4580	POTASSIUM (MG/L)		1.4	
ANIONS				
4103	CARBONATE (MG/L)		0.	
4102	BICARBONATE (MG/L)		269.	

APPENDIX A3.

4110	SULPHATE (MG/L)		10.
4104	CHLORIDE (MG/L)		72.
4105	FLUORIDE (MG/L)		0.17

HARDNESS

4203	CARBONATE HARD.-CACO3 (MG/L)		220.
4204	NONCARB. HARD.-CACO3 (MG/L)		24.
4205	CALCIUM HARD.-CACO3 (MG/L)		195.
4206	MAGNESIUM HARD.-CACO3 (MG/L)		49.
4202	TOTAL HARDNESS-CACO3 (MG/L)		244.

HEAVY METALS

4515	BORON;TOTAL (MG/L)		0.09
4545	IRON;TOTAL (MG/L)	<	0.005

DERIVED DATA

4201	SODIUM ADSORPTION RATIO		1.4
4209	SODIUM/TOTAL CATIONS (%)		30.2
4208	TOTAL CHLORIDES-NACL (MG/L)		119.
4200	LANGELIER INDEX		0.10
4210	ION BALANCE (%)		0.88

OTHER DATA

4160	SUSPENDED SOLIDS (MG/L)	<	1.

MANAGER STATE WATER LABORATORIES

NOTE - DETERMINATIONS WITH COMMENTS ARE FLAGGED WITH *

APPENDIX A4.

ENGINEERING AND WATER SUPPLY DEPARTMENT
04/02/83

WATER ANALYSIS REPORT

REPORT NO. 1

LOCATION NUMBER 520220 LOCATION NAME MOUNT GAMBIER - BLUE LAKE
STATION / DEPTH LAB.REFERENCE NO. 00309/83
SAMPLE DATE 12/ 1/83
SAMPLE NO. / TIME

GAUGE HEIGHT

CHEMICAL COMPOSITION

		MILLIGRAMS PER LITRE (MG/L)	MILLIEQUIVS PER LITRE (ME/L)
CATIONS			
CALCIUM	(CA)	43.	2.15
MAGNESIUM	(MG)	21	1.73
SODIUM	(NA)	62	2.70
POTASSIUM	(K)	3.2	.08
ANIONS			
CARBONATE	(CO3)	6	.20
BICARBONATE	(HCO3)	196	3.21
SULPHATE	(SO4)	21	.44
CHLORIDE	(CL)	95	2.68
NITRATE	(NO3)	14.11	.23
PHOSPHATE	(PO4)		
FLUORIDE	(F)	.19	

TOTALS AND BALANCE

TOTAL CATIONS (ME/L) 6.65 DIFF = .10
TOTAL ANIONS (ME/L) 6.75 SUM = 13.42

$$\frac{\text{DIFF} * 100}{\text{SUM}} = .74\ \%$$

TOTAL PHOSPHATE EXPRESSED AS P		MICRO-GM / L
SOLUBLE PHOSPHATE EXPRESSED AS P		MICRO-GM / L
TOTAL CARBON EXPRESSED AS C		MILLI-GM / L
TOTAL ORGANIC CARBON EXPRESSED AS C		MILLI-GM / L
NITRATE PLUS NITRITE EXPRESSED AS N	3.19	MILLI-GM / L

DEBIT NO. 5003
FILE FACTOR 20.0

DERIVED AND OTHER DATA

CONDUCTIVITY (E.C.)
MICROSIEMENS/CM AT 25C 665

	MILLIGRAMS PER LITRE (MG/L)
TOTAL DISSOLVED SOLIDS :	
A. BASED ON E.C.	370.
B. CALCULATED (HCO3 AS CO3)	380
C. RESIDUE ON EVAP. AT 180C	
TOTAL HARDNESS AS CACO3	195
CARBONATE HARDNESS AS CACO3	171
NON CARBONATE HARDNESS AS CACO3	24
HARDNESS DUE TO CALCIUM	108
HARDNESS DUE TO MAGNESIUM	87
TOTAL ALKALINITY AS CACO3	171
FREE CARBON DIOXIDE (CO2)	0
TOTAL KJELDAHL NITROGEN (N)	
SILICA (SIO2)	19
BORON (B)	
SUSPENDED SOLIDS	
PHENOLS	
TOTAL IRON (FE)	< 0.1
NITRITE (NO2-N)	
AMMONIA (NH3-N)	
CADMIUM (CD)	
DETERGENT	
ESTIMATED NA & K	

	UNITS
REACTION - PH	8.30
TURBIDITY (JACKSON)	
COLOUR (HAZEN)	
BETA EMISSIONS (PICO-CURIES / L)	
MERCURY (MICRO-G/L)	
LANGELIER INDEX	.630
SODIUM ADSORPTION RATIO	1.9
TOTAL CHLORIDES EXPRESSED AS NACL	157
SODIUM TO TOTAL CATIONS RATIO	40.64 %

STATE WATER LABORATORIES

WATER ANALYSIS REPORT

APPENDIX A.5

LOCATION : 3009 - EIGHT MILE CREEK AMTD 0.3 KM (EMC 3) 239508
DESTINATION : SEN CHEM WQA DEBIT NUMBER : 3000
SAMPLING DATE : 21.12.82 TIME : 1330 MULTIPLICITY : 0
LAB REF : 9419 TIME UNITS : 384

REMARKS

CERTIFIED AS CORRECT : ------------------------
SENIOR CHEMIST

CODE	DESCRIPTION	VALUE
GENERAL DATA		
4211	DISSOLVED SALTS-CALC (MG/L)	496.
4015	TDS-TOTAL DISS. SALTS (MG/L)	483.
4016	CONDUCTIVITY @ 25C (US/CM)	379.
4010	PH	8.0
4207	FREE CARBON DIOXIDE (MG/L)	4.
4101	ALKALINITY-CACO3 (MG/L)	221.
4017	COLOUR-TRUE @ 395NM (HAZEN)	2.
4018	TURBIDITY (NTU)	0.4
NUTRIENTS		
4109	PHOSPHATE-P,TOTAL (UG/L)	15.
4108	PHOSPHATE-P,SOL (UG/L)	6.
4161	OXIDISED NITROGEN-N (MG/L)	4.75 21.0 NO_3
4106	NITRATE-N (MG/L)	4.73
4107	NITRITE-N (MG/L)	0.02
4112	TKN-N (MG/L)	0.14
4111	SILICA,REACTIVE (MG/L)	14.
4158	TOTAL ORGANIC CARBON (MG/L)	1.
CATIONS		
4520	CALCIUM (MG/L)	74.
4555	MAGNESIUM (MG/L)	23.
4600	SODIUM (MG/L)	75.
4580	POTASSIUM (MG/L)	2.9
ANIONS		
4103	CARBONATE (MG/L)	0.
4102	BICARBONATE (MG/L)	270.
4110	SULPHATE (MG/L)	19.
4104	CHLORIDE (MG/L)	135.

4105	FLUORIDE (MG/L)		0.21

HARDNESS

4203	CARBONATE HARD.-CACO3 (MG/L)	221.
4204	NONCARB. HARD.-CACO3 (MG/L)	58.
4205	CALCIUM HARD.-CACO3 (MG/L)	185.
4206	MAGNESIUM HARD.-CACO3 (MG/L)	95.
4202	TOTAL HARDNESS-CACO3 (MG/L)	279.

HEAVY METALS

4545	IRON,TOTAL (MG/L)	<	0.005

DERIVED DATA

4201	SODIUM ABSORPTION RATIO	2.0
4209	SODIUM/TOTAL CATIONS (%)	36.6
4208	TOTAL CHLORIDES-NACL (MG/L)	222.
4200	LANGELIER INDEX	0.67
4210	ION BALANCE (%)	-0.27

OTHER DATA

4160	SUSPENDED SOLIDS (MG/L)	2.

MANAGER STATE WATER LABORATORIES

NOTE - DETERMINATIONS WITH COMMENTS ARE FLAGGED WITH *

APPENDIX A6

WATER ANALYSES

Bore	Date	Sampling Method	Temp. (deg C)	Cond.	pH	Dissolved Oxygen	COD	Salinity	Milligrams per litre									Milli-equivalents per litre								
									Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3	PO_4	Ca	Mg	Na	K	HCO_3	SO_4	Cl	NO_3	PO_4
Allendale Sinkhole	22/11/72	B	17·5	810	7·4	45	10	429	80	21	57	2	317	15	86	12	< 0·01	4·0	1·7	2·5	—	5·2	0·3	2·4	0·2	—
Ewens Ponds ..	21/11/72	B	17·5	760	7·4	8·8	5	387	73	20	46	2	290	15	73	15	< 0·01	3·6	1·6	2·0	—	4·8	0·3	2·1	0·2	—
Clarke Park Spring	22/11/72	B	17	980	6·7	4·9	15	478	73	25	76	2	295	15	128	14	< 0·01	3·6	2·1	3·3	—	4·8	0·3	3·6	0·2	—
Sand quarry, section 715, hundred of Blanche	17/11/72	B	15	720	7·3	10·0	10	401	83	19	41	< 1	306	10	60	37	< 0·01	4·1	1·6	1·8	—	5·0	0·2	1·7	0·6	—
Beach Spring ..	15/11/72	B	17	1 140	7·3	4·0	20	730	84	34	144	5	350	35	250	6	< 0·01	4·2	2·8	6·3	0·1	5·7	0·7	7·1	0·1	—
Spring, section 159, hundred of Blanche ..	20/11/72	B	14	970	7·0	8·8	15	513	98	11	81	1	295	20	125	32	< 0·01	4·9	0·9	3·5	< 0·1	4·8	0·4	3·5	0·5	—
BEN 12.......	1/12/72	W/M	22	800	7·7	10?	20	452	105	7	50	1	285	5	74	70	0·08	5·2	0·6	2·2	< 0·1	4·7	0·1	2·1	1·1	—
Little Blue Lake	12/12/72	B	19	520	8·0	10±	10	230	40	11	35	2	155	5	60	1	0·01	2·0	0·9	1·5	< 0·1	2·5	0·1	1·7	< 0·1	—
Bullock Hole..	12/12/72	B	16	740	7·2	7·4	15	370	80	15	45	1	290	10	75	2	0·02	4·0	1·2	2·0	—	4·8	0·2	2·1	0·1	—
Umpherstones Cave	12/12/72	B	15	2 475	7·8	—	40	1 520	208	45	230	9	110	605	320	45	0·13	10·4	3·7	10·0	0·2	1·8	12·6	9·0	0·8	—
Showgrounds Sinkhole	12/12/72	B	15	915	7·1	6·4	15	460	90	18	62	2	315	30	95	7	1·24	4·5	1·5	2·7	0·1	5·2	0·6	2·7	0·1	—
8 Mile Creek ..	12/12/72	B	18	1 000	7·5	10	15	465	70	24	78	2	290	15	130	3	0·01	3·5	2·0	3·4	0·1	4·8	0·3	3·7	0·1	—
Piccanninie Ponds Jetty..	12/12/72	B	18	3 900	7·1	7·5	40	2 045	94	83	560	19	335	130	995	< 1	0·01	4·7	6·8	24·4	0·5	5·5	2·7	28·1	—	—
Piccanninie Ponds Outlet	12/12/72	B	18	3 000	7·8	10	40	1 500	94	65	380	13	320	95	700	< 1	0·01	4·7	5·3	16·5	0·3	5·2	2·0	19·7	—	—

W/M—Windmill B—Bailed

FOSSILS FROM FOSSIL CAVE (GREEN WATERHOLE, L 81)

by *Dominic Williams*

At the time of the Conference, Dominic was studying for his Doctor of Phiolosophy in the Biology School at Flinders University. He has since completed his studies and is currently employed on a project at Adelaide University Zoology Department.

HISTORY

Fossils were first collected from Fossil Cave in about 1964, and were submitted to Mr. Brian Daily of the South Australian Museum. In 1968, Mr. Fred Aslin organised the first of a number of trips to the sinkhole, when Mr. Brian Brawley collected a number of skulls of extinct kangaroos from the surface of the rockpile in about 10m of water. Subsequent expeditions resulted in the collections increasing in size, and in 1974 Mr. N.S. Pledge of the South Australian Museum, with Messrs Aslin and Brawley, placed markers in the cave during fossil collection. These markers were later to be useful in our 1979 work.

When some C.D.A.A. divers from Flinders University returned with bones from Fossil Cave late in 1978, Rod Wells and I organised two expeditions. This was preceded by a week of diving, just to place lines and pegs on the rockpile. These were intended both as a safety precaution for the divers, and also a reference grid for locating fossils. As many cave divers have discovered, visibility suffers once the bottom is stirred up, and fossil-collecting inevitably releases clouds of fine sediment.

WHAT WE FOUND

A very large collection of fossil bones was made, most of which belong to extinct species of kangaroo. Previously these animals were only known from incomplete remains, and many species were first described from a few teeth alone. The Fossil Cave material is unique in containing whole skeletons. In some cases the skeletons were so perfectly laid out that we were able to collect tiny hand and ankle bones by telling the diver what we were missing, and where, in relation to the head, the missing bits might be found!

When one of these Sthenurine kangaroo skeletons was reassembled, it caused something of a surprise. Owing to the large size of the skulls of these animals, it had been widely believed that they were 'giant' kangaroos. However, the reassembled skeleton stood only about one metre tall - about the same as a smallish Grey Kangaroo today (see illustration). What they lack in height they make up for in having a stocky build, with a short neck, and a short tail. Their arms were long, and capable of reaching over their heads. Although their teeth tell us that they most likely ate leaves and twigs (unlike modern kangaroos, which are best adapted to eating grass), and consequently we would expect them to live in dense scrub, their feet seem to be even more specialised for fast hopping than modern kangaroos.

If the feet of a *Sthenurine* kangaroo are compared with those of say, a red kangaroo, we see that the fifth toe is almost lacking. Modern kangaroos have a fifth toe that is smaller than the fourth toe, but still functions. So the extinct 'roo had only a single large toe that functioned for hopping. This suggests that they once lived in open bushland.

It is this kind of study which allows us to find out the kinds of animals that once roamed Australia, and how they lived.

OTHER ANIMALS

Of course, other animals are amongst the fossils. There are bandicoots, wallabies, rats and bats represented. Most of these animals are indistinguishable from their modern descendants, but amongst the larger kinds there are bones of the extinct Marsupial Lion. This was most likely a meat-eater, the size of a large dog, and with a formidable set of bolt-cutter teeth. Other strange kinds of kangaroo are also present, such as the giant rat-kangaroo, *Propleopus*, about which little is known.

There is a large collection of bird bones as well. Dr. Pat Rich and Dr. Gerry van Tets are studying these. So far they have identified bones of water-hen, crow, pigeon, parrot and others. Perhaps the most interesitng are the bones of a giant eagle, now extinct, and a new species of cuckoo, also extinct.

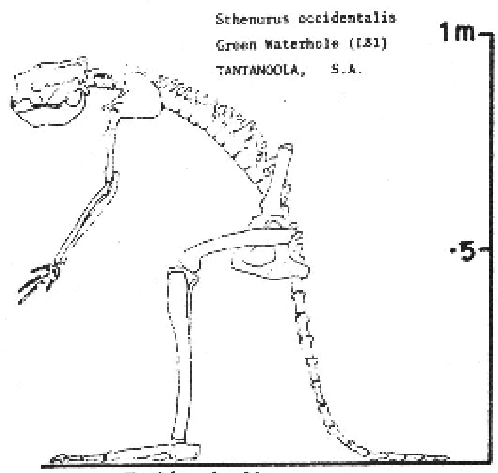
WHAT WAS IT LIKE WHEN THE BONES WERE ACCUMULATING?

There are various ways to try and reconstruct the conditions that once existed in and around Fossil Cave. One of these is by extracting fossil pollen grains from the cave sediment, and identifying them. It is a complex process, as pollen from some plants might come from a great distance on the wind before it filters down into the cave. However, we expect to get some idea of the vegetation around the cave as it was in the past.

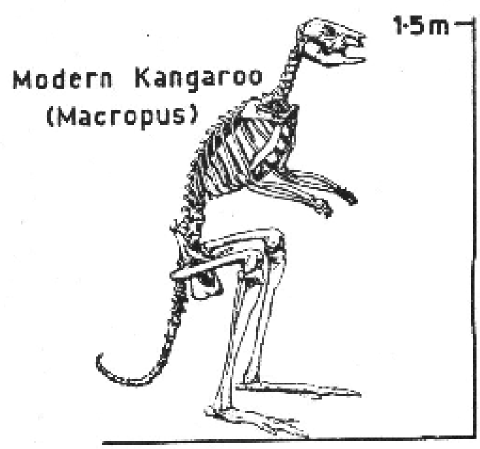
Various lines of evidence suggest that Fossil Cave was not always full of water, as it is now. The bones of birds, bats and the larger animals are unlikely to have got so far down the cave unless the water-level was lower. Some bones from deep in the cave have the gnaw-marks of rats on them, which means that at times there may only have been a pool of water right at the bottom. This fits in with what we know about sea-level. At various times in the last few hundred thousand years, world sea-level has dropped by at least a hundred metres. This would mean that the water-table at Fossil Cave would drop, as it is near the coast. It seems likely that the fossil deposit is related to one of the low sea-level periods - but which one?

HOW OLD ARE THE FOSSILS?

This is proving to be a difficult question to answer. The main problem is that the cave sediments and the fossil bones are draped over a tumbled pile of rocks, so that any layering is hard to detect. This is made more difficult since it is under-water where observations are difficult to make. It may never be possible to give the fossils an exact age. All we can say at present is that the bones are of Pleistocene age - that is, younger than 2,000,000 years or so; from the evidence of low sea-levels we can say that the fossils are at least 17,000 years old. (That was the time of the latest low sea-level.) However, there have been a number of low sea-level periods before that, and we don't know which of these it might be. However, our study of the fossils and Fossil Cave are at an early stage, and there is much to be learned from the fossil pollen, carbon dating, and studies of the sediments.



Extinct Kangaroo



SUMMARY

As a result of the diving at Fossil Cave, a huge amount of knowledge is accumulating. The difficulties of collecting bones from the cave will be appreciated by all cave divers, especially so when it is realised that each dive was carefully logged as to the position of every bone before it was collected. It has been said that for such collections, the most important part is the label - a fossil with no label is virtually useless.

I would like to finish with an invitation to C.D.A.A. members to keep an eye open for possible fossils. If you do see what looks like a fossil, the best approach is to collect a small, separate bone. Remember where it came from exactly in the cave, and show it to an expert, either at a Museum, or at a University. Don't worry if it looks like a cow-bone - that's what Peter Rogers thought when he brought in the leg of an extinct kangaroo!

But please - don't start a major fossil dig without consulting an expert first. Remember that the most important information is in where the fossils are, not so much what they are.