## *Underwater Helictites from the Nullarbor*

**Jill Rowling**

### INTRODUCTION

In January 2001, Paul Hosie, a member of Trimix Divers (Hosie 2001, 2002), announced on the internet mail list "Ozcavers" that their team had discovered a number of peculiar underwater helictites present in lakes in Mullamullang Cave, one of the caves of the Nullarbor. Members of the Trimix Divers club are investigating the underwater sections of Mullamullang Cave and record their findings of unusual speleothems. These include a thick wall-deposit and at least eight different kinds of helictites.

In order to identify the helictites, Paul Hosie sent a number of digital pictures to interested people. Samples of two different varieties of helictites were posted to Jill Rowling for identification. Preliminary descriptions and classifications were passed onto Paul. Classification was based on the present scheme devised by Hill & Forti (1997), however a more comprehensive analysis was required (as Paul says) "to do justice to" these peculiar speleothems.

This paper covers the analysis and description of two of the helictites. The helictites examined are of two forms: one which is a cylindrical shape ("pool fingers") and the other which has an almost triangular symmetry and flattened structure ("sh'bulatites").

The helictites have a rather unconventional layered structure. Minerals present include high and low magnesium calcite, aragonite, hydromagnesite, huntite and others (see Tables 2 and 3). The substrate appears to be a reddish deposit with large limestone blocks apparently collapsed into it. The helictites develop vertically from the blocks (so perhaps they should be called heligmites).

Mullamullang Cave is on private property. Trimix Divers obtained all permissions for diving and sampling with the property manager.

### HISTORY OF DISCOVERY OF SUBAQUEOUS HELICTITES

| | |
|---|---|
| **January 2001:** | Announcement on the internet by Paul Hosie regarding the discovery of unusual helictites during a recent dive in the lakes of Mullamullang Cave, Nullarbor Plains. Includes photos from the dives and a request for identification of the speleothems. |
| **29th January 2001:** | Paul Hosie mentions on the internet that disc shapes are part of some helictite structures. |
| **5th February 2001:** | Rowling receives helictite samples and begins analysis. |
| **12th December 2001:** | Further internet discussions regarding helictite classification. |
| **16th April 2002:** | XRD results discussed via internet. |
| **19th April 2002:** | Paul Hosie develops project plan to record the subaqueous helictites of Mullamullang. |

### LAKES WITH SUBAQUEOUS HELICTITES

Mullamullang Cave has several lakes. According to the divers, some of them have subaqueous helictites. Table 1 lists the lakes and the type of speleothems recorded to date (data and names are from Trimix Divers). There are at least eight different helictite forms estimated (P. Hosie, pers. comm.).

Photos of some of these speleothems may be seen on the Trimix Divers website, http://www.trimixdivers.com in the section on Mullamullang Cave.

| Lake | Distance From Entrance | Speleothem |
|---|---|---|
| White Lake | 2.5 km | Fine coral branches<br>Pool fingers<br>Fat fingers |
| Easter Lake | | Crystal coating |
| Lake Sh'Bula | 5.2 km | Crystal matting<br>Robust coral branches (“sh'bulatites") |
| X Lake | | Passage floor needles<br>Stacked branches<br>Roof fingers<br>Boulder coatings<br>Crystal floor plates<br>Chalky wall deposits |
| Helictite Lake | | Crystal matting |
| Grotto Lake | | Not studied yet |
| Lake Cigalere | | Not studied yet |
| S Lake | | Not studied yet |
| Keyhole Lake | | Not studied yet |
| Gurgle Lake | | Not studied yet |

***Table 1 - Mullamullang Lakes and Speleothems (after Hosie)***

**ANALYSIS OF WHITE LAKE POOL FINGER HELICTITES**

The samples forwarded for analysis consisted of three "fingers": One was loose and the other two joined together. They are approximately 45 mm long and 7 mm diameter with cylindrical symmetry. The tip is hemispherical. To the naked eye they are white and chalky on the outside, with patches of yellow, and inside they are hard and crystalline.

Under the microscope, the outside coating has a porous appearance. The whole surface is coated in triangular crystal outgrowths with a clear yellow outer coating. The surface has fine black speckles resembling soot. One of the specimens had an empty shell of a small crustacean adhering to the surface, possibly a syncarid. At the tip of the helictite the thin surface layers of white crystalline material can be seen. The inner crystalline part of the helictite appears to be made of concentric layers.

One of the helictites was sectioned and viewed with the microscope on both reflected and transmitted light. The innermost area appears to comprise several hollow capillary tubes surrounded by a wider area of radial needle crystals. Some needles appear to be in bunches and flattened. Also in the inner layer is some more yellowish material. In the sampled section, there is a hard inner layer which forms a triangular pattern.

Some layers are white and chalky. They reflect white light but transmit light poorly: this is a property of powdery minerals such as hydromagnesite or huntite. Other layers are more transparent and fairly hard.

A small part of the helictite was powdered, mounted on a glass slide using double sided tape and scanned with a Siemens D5000 Xray diffractometer using a copper target. The Xray spectrum was analysed using Bruckner Diffrakt-Plus software. The results of the analysis are given in Table 2 and its Xray spectrum is shown in Figure 1. The main peaks seen were calcite and magnesian calcite, with aragonite, hydromagnesite, gypsum, celestite, graphite and some halite present.

One assumes the halite, and the strontium in the celestite are from wind-blown sea water and deposited in the cave as part of the ground water.

Using the speleothem classification system of Hill & Forti (1997), possibly they could be classified as Type: Helictite; Subtype: Subaqueous; Variety: Heligmite.

| Mineral Class | Mineral | Cat. No |
|---|---|---|
| Native Elements | Carbon (Graphite) | 01-0640 |
| Halides | Halite | 02-0818 |
| Carbonates | Aragonite | 41-1475 |
| | Calcite | 03-0612 |
| | Hydromagnesite | 03-0093 |
| | Magnesian Calcite | 43-0697 |
| Sulphates | Celestite | 01-0885 |
| | Gypsum | 33-0311 |

***Table 2 - XRD results for Pool Finger helictite***

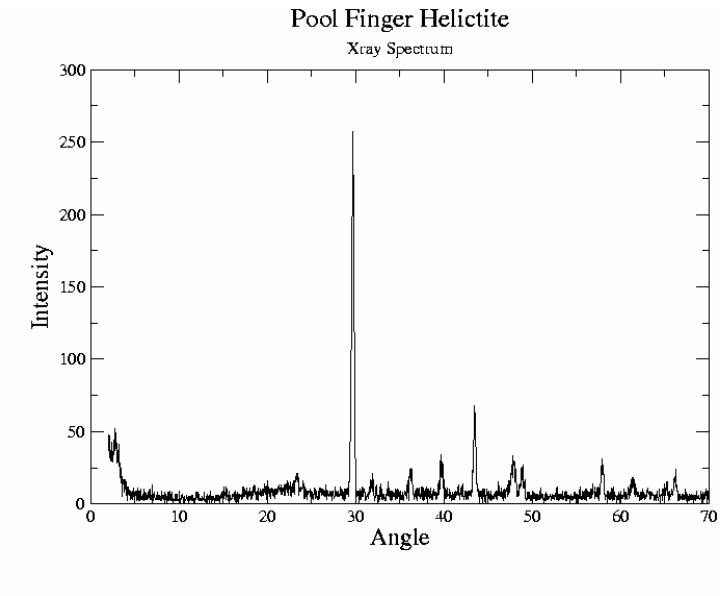


***Figure 1 - Xray spectrum of Pool Finger helictite. Vertical scale: counts; horizontal scale: 2$\theta$***


***Figure 2 - Pool Finger helictite samples***

***Figure 3 - Pool Finger helictite - tip detail***

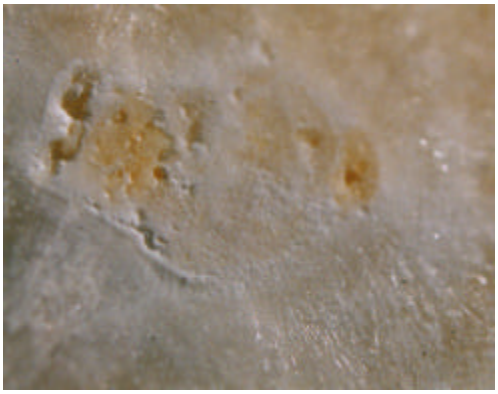

***Figure 4 - Pool Finger helictite - cross section detail in reflected light***
*Note the multiple central canals*

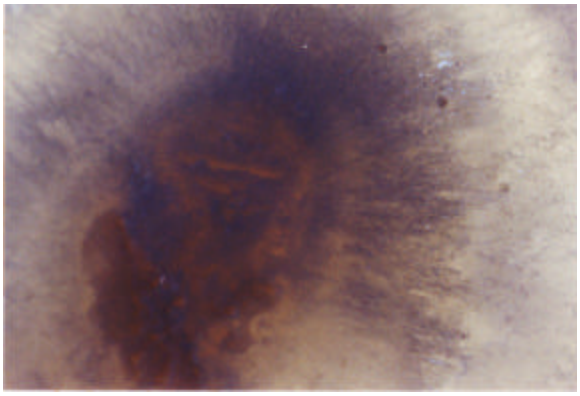

***Figure 5 - Pool Finger helictite - cross section detail in transmitted plain polarised light***
*Note the triangular central area and the radial aragonite region.*

**ANALYSIS OF LAKE SH'BULA HELICTITES**

The specimen is a white and yellowish aggregation of roughly square plates forming a rough-surfaced triangular prism. At first glance it resembles cave coral rather than a helictite, however it has a number of flattened capillary tubes which mean it is classified as a helictite. The specimen is about 40 mm long and about 30 mm diameter at its base and forms a rough triangular pyramid. A broken section exhibits ray-fan crystals presumably of aragonite.

Under the microscope, the surface appears to be chalky with small dark specks. The plates on the surface are squared, possibly by crystal twinning. Near the center of the helictite, some of the plates resemble gypsum swallowtail twins. On the surface there appear to be the remains of microbial veils. Development may be by twinning near the surface. The white powdery matrix appears to be porous, and the needle core is definitely porous.

The interior is similar to the Pool Finger sample except that the central canals are extremely elongated. The insides of the flat plates are hollow, and lined with needle crystals with alternate layers of clear and opaque white minerals.

Its cross section is rather similar to the Pool Finger sample but with a tendency to form flat plates instead of cylinders. At first, it was thought that these plates may be sunken and overcoated calcite rafts, however the divers recorded them from all sorts of places in the lake where it is extremely unlikely that rafts would form. P. Hosie describes other raft-like structures in similar helictites as being about 5 mm thick and 25 mm diameter.

One interesting feature of these helictites is they appear to have macroscopic triangular symmetry, with the outer "petals" of the helictites developing along the edges of a regular triangular prism.

A small part of the helictite was powdered, mounted on a glass slide using double sided tape and scanned with a Siemens D5000 Xray diffractometer using a copper target. The Xray spectrum was analysed using Bruckner Diffrakt-Plus software. The results of the analysis are given in Table 3 and Figure 6. The main peaks seen were calcite, aragonite and magnesian calcite, with huntite, hydromagnesite, cristobalite, gypsum, graphite and some halite present. Specimen grinding was surprisingly difficult but could have been because of the presence of cristobalite.

| Mineral Class | Mineral | Cat. No |
|---|---|---|
| Native Elements | Carbon (Graphite) | 41-1487 |
| Halides | Halite | 01-0993 |
| Carbonates | Aragonite | 01-0628 |
| | Calcite | 02-0629 |
| | Hydromagnesite | 08-0179 |
| | Huntite | 14-0409 |
| | Magnesian Calcite | 43-0697 |
| Silicates | Cristobalite | 39-1425 |
| Sulphates | Gypsum | 33-0311 |

***Table 3 - XRD results for Lake Sh'bula helictite***

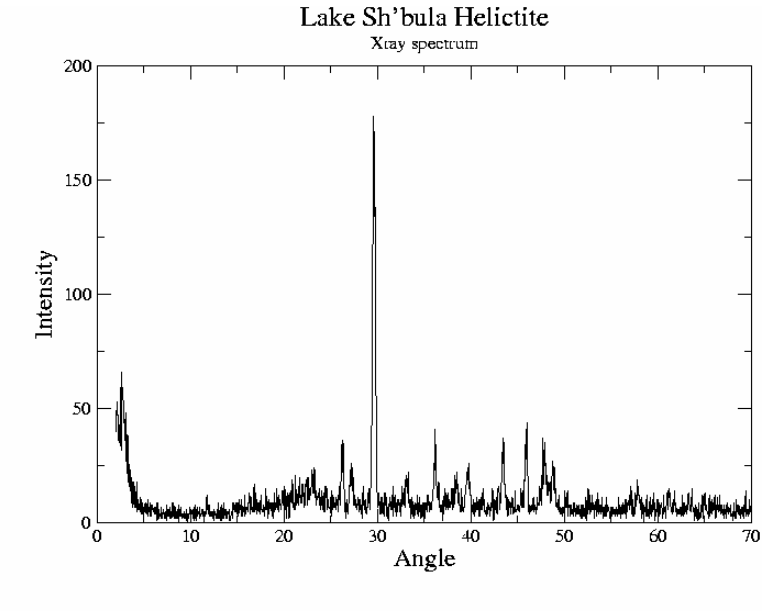


***Figure 6 - Xray spectrum of Lake Sh'bula helictite***
*Vertical scale: counts; horizontal scale: 2q*


***Figure 7 - Lake Sh'bula helictite sample***

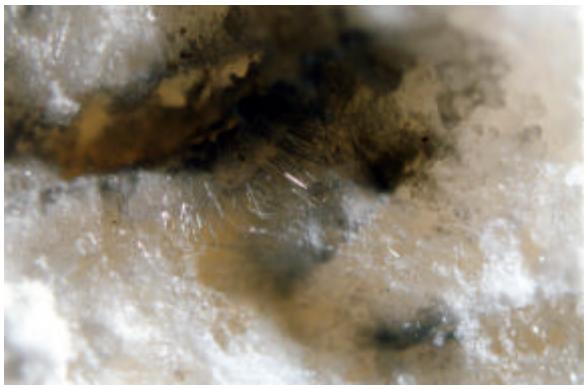

***Figure 8 - Lake Sh'bula helictite - cut section detail in plain polarised light***
*Note the elongated central area and the radial aragonite region*

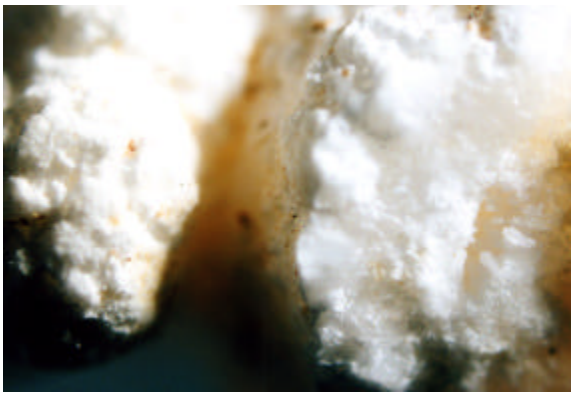

***Figure 9 - Lake Sh'bula helictite - cut section near the end of the helictite***

Using the speleothem classification system of Hill & Forti (1997), possibly they could be classified as Type: Helictite; Subtype: Subaqueous; Variety: Heligmite. However this is problematical as the rather elongated central canals of these helictites should be distinctive. Possibly they are part way to being a cave shield, as the elongated central canals are similar to the conventional cave shield in many respects. The central canals appear to form a twin plane, so whatever develops on one side of a plate also develops on the other side. The overall triangular symmetry may also be due to twinning.

An interesting discussion of a small aragonite cave shield may be found in Hill & Forti (1997) in the special section on the Blue Cave of France (page 314).

**OTHER HELICTITES AT MULLAMULLANG**

There are a number of other helictite types reported by the Trimix Divers from lakes at Mullamullang Cave. Some of these are recorded as digital images by Paul Hosie as follows:

**Lake Sh'bula helictites:** Some of these are developed on cave shields or the upper edge of a stegamite. Others appear to be developed on tepee structures or rock surfaces. Some helictites are spheroidal or cylindrical, others have a triangular shape. There are yellow platey helictites which resemble overgrown sunken cave rafts but form the upper edge of a stegamite.

**White Lake helictites:** Fine white helictites take on a branching form. All tips go upwards. About a dozen tips per "shrub". "Shrubs" about 200 mm height and diameter, wider at the top than at the bottom forming a cone shape. They apparently develop on top of rocks in the lake. Small discs are apparently embedded in some of these helictites (P. Hosie, pers. comm.) which could be similar to the "sh'bulatite" variety, only smaller.

**Crystal matting:** This is a wall surface coating which superficially resembles Cave Clouds (Hill & Forti 1997). Closer, the surface appears to be made of spheroids. Without seeing more of it, it may be still a variety of Cave Clouds. According to the divers, it occurs in areas where microbial veils have been recorded. Where it occurs, the boulders are completely coated in this "crystal matting".

**Fat fingers:** Paul said there were not many of these. Close up photos show some standing, some naturally toppled helictites. The substrate appeared to be pink silt and reddish (rock or sediment). A yellowish coating appears on some helictites.

Some of Paul's pictures are included as an appendix to this paper.

## CONCLUSIONS AND ACKNOWLEDGEMENTS

Subaqueous helictites have not often been recorded, and this discovery from the Nullarbor shows that there must be something special about the cave chemistry to cause helictites to occur in these lakes.

The association between the "sh'bulatites" and stegamites or vertical cave shields would be worth investigating further. The above-water cave analogy to this association would be the regular vermiform helictites that develop along the edges of cave shields.

In contrast, the pool finger helictites appear to develop on bedrock blocks.

In summary, the subaqueous helictites of Mullamullang Cave have only started to be analysed. Discovery was only possible by cave diving. It is hoped that the divers will discover more of these interesting speleothems. The study of these fascinating helictites has been an interesting exercise in remote analysis. The author has never been to the Nullarbor (yet) but the ease of corresponding by internet for the exchange of photos and ideas has been invaluable. All field work was done by members of the Trimix Divers group, assisted at times by various (dry) cavers such as members of WASG and SUSS. Photographs of the Mullamullang helictites *in situ* were done by Paul Hosie.

All sample preparation, XRD work and spectral analysis was done by the author using equipment at the Electron Microscope Unit at the University of Sydney. All optical microscopy and specimen photography was done by the author using optical equipment at home and at the School of Geosciences, the University of Sydney.

Specimen photo scanning was done by Dr Phil Maynard at the Forensics Dept., the University of Technology, Sydney.

This paper has benefited from constructive criticism by Paul Hosie.

## REFERENCES

HILL, C. A. & FORTI, P., eds (1997). *Cave Minerals of the World*, 2nd edn, National Speleological Society, Huntsville Alabama, USA.

HOSIE, P. (2001, 2002). Trimix Divers website, Internet: http://www.trimixdivers.com.

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**APPENDIX - PHOTOS BY PAUL HOSIE**

***Figure 10 - Coral Fingers***
*Original photo copyright 2001 Paul Hosie*

***Figure 11 - Crystal Matting***
*Original photo copyright 2001 Paul Hosie*

***Figure 12 - Fat Fingers***
*Original photo copyright 2001 Paul Hosie*

***Figure 13 - Sh'bulatites, variation***
*Original photo copyright 2001 Paul Hosie*

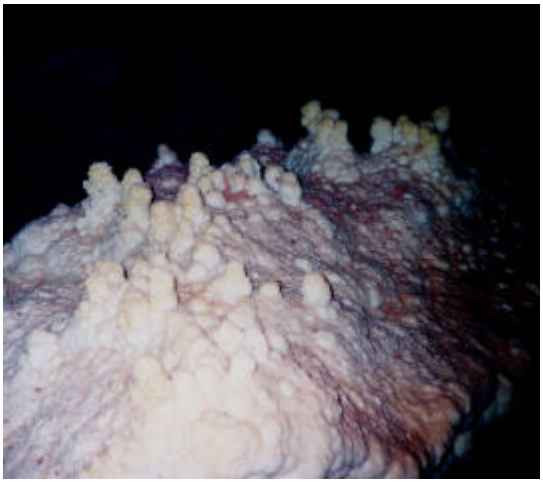

***Figure 14 - Sh'bulatites, variation***
*Original photo copyright 2001 Paul Hosie*