METHOD OF REPARING THE ROOTSICLE IN WILDMAN'S CAVE _ WOMBEYAN

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Note; for general information I have included a Rootsicle definition at the end of this summary of the restoration.

Broken rootsicle. Photo by G.K.Smith.

Situation

There were 15 pieces of shattered speleothem rootsicle which when realigned in order measured approximately 2 metres overall. The repair of the broken rootsicle as opposed to a standard stalactite, presented a number of unique problems to be overcome.

- The centre of the rootsicle consisted of extremely decomposed timber (tree roots) with a consistency of paper mashay and a jet black colour.
- The centre core (rotten timber) was extremely wet and held the water like a sponge.
- The calcified layers over the original tree roots were in places very thin (2-3 mm).
- Toward the middle of its length, the rootsicle split into two before rejoining over the last 750mm of length. The lower section consisted of solid calcite, thus making it much heavier than to the upper section.
- The attachment point on the cave roof had a constant drip of water which became even worse when drilled to accommodate glue and an anchoring pin (threaded bar).
- The correct alignment of the rootsicle meant that when installed it would be hanging on a slight lean. Hence a jack or mechanical support system during the glue setting period was not practical.
- The height of the roof meant that a small step ladder was required to gain access to the attachment point for drilling and gluing.

The segments laid out in assembly order. Photo by Sonia Taylor-Smith.

Equipment used

Ground sheet, packing foam, DSI chemical anchor glue, Super Glue, 5 minute Araldite, battery drills and extra batteries, specially sharpened carbide tipped drill bits, dust puffer with ling thin tube, 316 grade stainless steel threaded bar (4mm, 6mm & 8mm), surgical gloves, glue mixing spatula and mixing tin, step ladder, cloth rags, hammer, cold chisel, pliers, hacksaw, scissors, air puffer and two way radios.

316 Stainless steel threaded rod was used as this grade of stainless is salt water resistant and as such will not corrode in cave conditions. There were three sizes of threaded bar used. These were pre-cut into pins of lengths:- M4x50mm long, M4x75mm long, M6x75mm long, M6x100mm long and M8x100mm long.

Drilling hole for support pins. Photo by Sonia Taylor-Smith.

Equipment selection methodology

Surgical gloves were used to reduce contamination of the speleothem from skin contact and perspiration as well as to protect the workers from contact with glue.

Checking the alignment, before inserting pins and gluing. Photo by Sonia Taylor-Smith

The DSL chemical anchor tube containing the glue is the type used in coal mining for rock bolting and is manufactured by Dywidag-Systems International PTY Limited. It is a high strength polyester resin which sets quickly in water and sticks to almost anything. The composition varies with the grade of DSL anchor tube and generally fits into the range of:- 6.9% – 11.9% Polyester Resin, 78% – 87% Calcium Carbonate, 4.4% – 6.0% Water. The DSL chemical anchors used for this repair contain two colours (green & brown) of glue and a white internal hardener tube, all contained in the one plastic tube. When the green and white agents were mixed together they set in about a 2 minutes, while the brown and white set in about 10 minutes. Obviously the cave temperature will have some bearing on setting times.

Clear setting 5 minute Araldite was used on the mating faces of the speleothem as the glue dried quickly and went clear when dry. This allowed the excess glue on the outside of the speleothem, to be easy wiped off or scraping away when partly set.

Tungsten carbide masonry drill bits were sharpened so as to have a positive rake similar to a metal cutting drill (not sharpened like a masonry drill bit with negative rake). The drilling speed was slow so as to reduce heat generation in the speleothem. The hammer (percussion) setting on the battery drilling machine was not used, so as to reduce vibration of the fragile speleothem segments. Cooling water could be used if the speleothem or drill bit started to warm up.

Because the repair was in a chamber not far from the surface, we were able to use two way radios to communicate with people on the surface, in the event that we needed extra equipment or assistance. The entrance pitch was tight so the radios saved lots of trips back and forth to the surface.

There are now just 2 pieces to join. Photo by Sonia Taylor-Smith

Repair sequence.

The segments were first aligned on a ground sheet in their correct order and orientation, then each mating joint checked for small missing chips. Sorting out the jigsaw and aligning segments in order was certainly a challenge.

Enlarging the support pin hole before the final connecting to the roof. Photo by Garry K. Smith

Once satisfied that all components were accounted for, a battery drill with specially sharpened tungsten bit was used to carefully drill down the centre of the speleothem. This usually coincided with the path of the rotten tree root. Everyone coming in contact with the speleothem wore surgical gloves.

One person held a section firmly against a solid support for another person to drill out the centre hole just over half the length of the stainless steel support pins. The holes were drilled several millimetres larger than the diameter of the pin to be used. This allowed some room for glue and assisted in aligning the outside

surfaces. For the sections where the centre consisted of rotten wood, as much of the rotten material was removed as possible, to ensure the adhesive had a solid surface to bind to.

Threaded pin glued in a more solid section. Pin on axis of rotten tree root. Photo by Sonia Taylor-Smith.

Once both mating pieces were drilled, the pin was inserted without glue to check that the adjoining outer surfaces of speleothem could be aligned exactly. If needed the holes were enlarged to allow room for the pin to float more freely, so as to align the outer surfaces.

When all mating parts could be aligned, gluing commenced. The appropriate quantity of glue was squeezed out of the DSL chemical anchor tube onto the bottom of a tin can for mixing with a spatular. On most occasions the slower setting chemical anchor glue was mixed up and smeared on the pin and inserted into the hole. Once the glue covered pin was pushed into one piece, the Araldite was put on the speleothem faces and the two halves pushed together. Excess clear Araldite was then wiped off the outside of the joint. On most occasions it was easier to let the Araldite partly set, before scraping the excess off. This reduced the smearing of sticky glue on the outer surface of the speleothem.

To reduce waiting time fast setting Superglue was used to fix a few small chips in place.

Because of the overall length of fragile speleothem, the sections were joined to make two complete halves and then they were joined together while resting on foam supports.

After all our efforts the top half remained attached to the ceiling, however the middle section was very weak with little calcite around the rotten tree root and could not support the weight of the bottom section which fell off.

Andrew with the repaired rootsicle before attempting to attach it to the roof in Wild Mans Cave. Photo by Garry K. Smith

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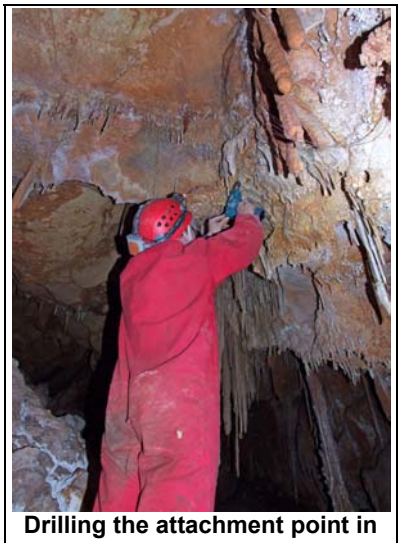
Photographers were Sonia Taylor-Smith, Jodie Rutledge, Andrew Baker & Garry Smith



Drilling the attachment point in the ceiling to accommodate the support pin. Photo by GKS.

Inspecting the portion of rootsicle which stayed attached. Photo by GKS.

Definition.

***ROOTSICLE**. n. roots of trees or plants which grow into a cave cavity and become calcified. The roots and **speleothem** comprising the rootsicle. This is very similar to a **RHIZOMORPH** which is a **speleothem** originally formed around tree or plant roots, which may have long since decayed, but the calcareous deposit has preserved their shape and form.*