Speleothem Repair
Planning and Documentation

Val Hildreth-Werker and Jim C. Werker

More people are visiting caves. Increased visitation generally results in more broken speleothems. Whether damaged through acts of ignorant vandalism, blatant carelessness, or inadvertent clumsiness, some of the busted formations can be repaired. As with any cave restoration project, before making decisions carefully consider the potential environmental impacts of repair materials, equipment requirements, and safety measures.

The first objective in speleothem repair is to avoid creating new problems—first, do no harm. Before starting a repair project, get permission from the landowner, manager, or agency. Go into the cave, look at the site, and evaluate the potential problems. Talk over the repair tasks and logistics, consult with others, bounce ideas around, and make certain the broken pieces fit tightly together—then make decisions about the repair technique to use.

Is it best to repair it or leave it alone? In some cases, doing nothing at all may be the best answer. Evaluate the potential repair from all angles and become aware of materials that are safest for long-term use in caves.

Materials that are considered reasonably safe for long-term cave applications are listed in the speleothem repair materials chapter (pages 445–450). Adhesives are notorious for introducing nasty substances into natural environments. Inexpensive adhesives may set up quickly and may appear to work okay, but the cheaper consumer glues and epoxies often have detrimental degradation characteristics, toxic outgassing, and rapid deterioration of chemical bonds. (See archival epoxies and adhesives, page 172 and page 446.)

Obtain manufacturer data sheets that detail the chemical properties of repair materials. Also check the federally regulated Material Safety Data Sheets (MSDS) that discuss hazards and the specific safety precautions for most products and materials. (See MSDS, page 70 and page 172.)

Know about the repair products you are using and ask for assistance in predicting how the product may react in cave environments. Consult with biologists, geologists, chemists, and other specialists working in speleological disciplines to ascertain the effects of various materials on specific cave environments. (See materials, page 167.)

Explore These Questions

Before starting a repair project, get permission from the landowner, manager, or agency. Go into the cave, look at the site, and evaluate the potential problems.

Is it natural breakage? Most speleologists agree that speleothem pieces should be left alone if the break was caused by naturally occurring environmental changes. Repair the break if the damage was caused by human interference.
Do the pieces actually fit each other? Most speleothem repair experts agree that orphan speleothem pieces should not be glued together to create a new formation out of unmatching broken pieces. Likewise, it usually is considered unethical to add speleothems where none were naturally placed by time and deposition.

What about fabricating missing chunks? It is often reasonable to restore an incomplete formation by filling in gaps with a mixture of epoxy and rock dust. However, it is usually considered inappropriate to fabricate or recreate totally missing speleothems.

What if calcite deposition prevents tight alignment? If new speleothem material has deposited on top of an old break, it may be inefficient or detrimental to attempt repair. However, this handbook offers several pinning and fabrication techniques that have worked in reconstructing speleothem joints disfigured by light calcite deposits.

Will the repaired speleothem be safe from future damage? Should it be repaired anyway—regardless of security factors or potential for additional vandalism?

Is a repair attempt worth the potential harm? What is the probability that more damage will be caused during the repair?

What are the safety considerations? Are scaffolding and fixtures needed to raise the formation into place? Should cavers or broken pieces be tied off for safety due to the location of the repair? Caution should prevail when repairing heavy speleothems. Evaluate location and weight before rehangg heavy stalactites. Consider liability issues before attempting repairs.

Cave dwellers? Will critters be affected by fumes from the adhesives or residue from the glue? Do bats use the site? Invertebrates? Other organisms?

Cleanup? Include planning for the logistics of cleanup after the project is complete. Remove all indications of the repair crew’s presence.

Residual effects? Evaluate the potential residual effects of any proposed repair. Because all materials will eventually break down and the byproducts may be harmful, minimize the use of human-introduced materials as much as possible.

More Questions for the Pre-Planning Phase
Always plan in advance—before initiating the hands-on work. Reconnaissance trips set the stage for success and help prevent poor performance. Here are a few planning pointers for speleothem repair projects.

Where is the speleothem located? What are the logistics of reaching the repair site?

What materials are needed? What tools are required?

Scaffolding? Will the formation require fixtures for lifting and holding it in place until the epoxy cures?

Timing? If the repair is in a show cave with tours, timing may be important. Discuss scheduling with the cave manager so the administration agrees with and approves of the project.

Is the repair in an area with a lot of speleothems? Assign spotters to help the team avoid breaking more formations.

What type of adhesives will work for the specific repair? Is the area wet or dry? Remember, just because an area is dry now doesn’t mean it will be in the future.

Personnel? Don’t arrange for more help than is required to complete the job. Extra bodies create additional safety concerns.
Repairing a Stalagmite on a Slope
in Slaughter Canyon Cave

Figure 1. Pieces of a stalagmite rest on the slope where this speleothem was broken in Slaughter Canyon Cave, Carlsbad Caverns National Park.

Figure 2. Since the repair is performed on a sloping flowstone surface, cavers and large broken pieces are secured with safety lines.

Figure 3. A stabilization pin made of stainless steel all-thread is epoxied into the center of the upper part of the broken stalagmite.

Figure 4. Jim Werker drills a larger hole in the stump to receive the stainless steel pin.

Figure 5. New calcite deposition on the break prevents solid mating of two pieces. Small rocks fill the gap between broken pieces and provide additional support.

Figure 6. Pulverized rocks and archival epoxy form a thick, color-matched mixture for filling cracks and gaps in repaired speleothems.
Repairing a Stalagmite in Slaughter Canyon Cave (continued)

Figure 7. A thick mixture of rock dust and archival-grade epoxy is pushed in place with a craft stick to fill and sculpt the gap.

Figure 8. Repaired with stainless stabilization pins and archival epoxy, the reassembled stalagmite again stands tall on its base of sloping flowstone.

Figure 9. In Lower Cave of Carlsbad Cavern, Jim Werker used Epon 828 and Versamid 40 with a 3-inch 10-24 UNC stainless steel all-thread stabilizing pin to rehang this stalactite on June 5, 1999. Stan Allison, Cave Technician at Carlsbad Caverns National Park, assisted in the planning. (See additional photos of this repair, page 468.)

Document Repair Sites—Before and After

Use photos and written accounts to document speleothem repair projects. Make pictures of breakage and damage, repair procedures, personnel, and completed repair sites. Use photographs for historical documentation and file them with written reports that describe the methods and materials. Include mechanical drawings to enhance reports.

File the documentation in two or three separate places—historical information is useless if nobody can find it. Always provide a file for the landowner, manager, or agency. Submit a report to the local grotto or region files. Project reports may also be submitted to the NSS library for archiving. Why should repair projects be so thoroughly documented?

Before and after photographs are impressive historical documents that may be used for interpretation, research, educational outreach, protection, and funding opportunities.

Photograph repair procedures to report, document, and evaluate the techniques employed.

Documentation may help stewards identify the cause and make corrections if future abnormalities occur near repair sites. Reports may help in future planning for similar projects. Documentation can become a teaching aid for sharing repair how-to instructions.

Future cavers may be able to check on the longevity of repairs if a few details are documented. At least take pictures, record the date, the type of adhesive used, type of pin installed (if it has one), name of the cave and passage (if appropriate), and names of those who participated in the repair. (See photodocumentation, page 204.)

History is worthless if nobody can find it. File redundantly.