

Fort Stanton Cave Formation Repair and Restoration Project: The Tools and Techniques We Used

by Mike Mansur, Project Leader

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We began our project in August 2020. Our goal was to locate and repair as many broken formations as possible in the three trips we had approved. The location in the cave was the Lake Room, which had been identified as a good starting point by Pete Lindsley, Ron Lipinski, and Knutt Peterson.

Below I introduce some of the inventions I have created to make our formation repairs easier, but first I want to introduce an invention by Todd Roberts, one of the project participants. Todd created a great method of photographing the broken formation ends, and then printing them in color and to scale so we could hold the paper up to the ceiling to find matches. We created these new inventions for use in formation repairs in Carlsbad Caverns National Park, Lincoln National Forest, and BLM caves. These made the repair process very easy. Todd Roberts and Minori Yoshida have helped on most of my formation repair projects over the last three years. Todd developed a great idea for matching the broken ends with their points of origins. The normal way of trying to locate these matches was to hold one piece up to the ceiling and walk or crawl around the room to try to find the base. His clever idea was to arrange the pieces by number, photograph the ends to scale, and then put twenty photos onto a sheet of colored photographic paper, which could then be held up to the ceiling to compare with the bases. We used this method in Cottonwood Cave, and found 7 matches in 30 minutes. We wanted to use this same method in Ft. Stanton Cave. Todd invented a device to mount to his camera that would ensure consistent results with a ruler and a counter for scale. We have used this in Ft. Stanton as well.



Todd's broken formation photo documenting system. Photo by Todd Roberts.

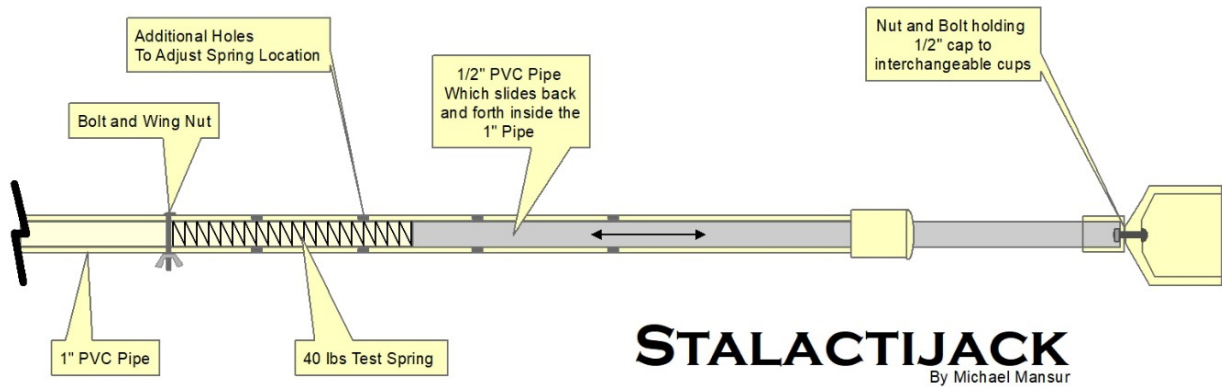


Todd's printed photos we use to match broken pieces to their point of origin. Photo by Mike Mansur.



Todd using his brilliant formation-end photo documenting method which he will then print onto photo paper. Photo by Mike Mansur.

My own inventions of specialized tools are physical supports that stabilize broken formations while the epoxy we use for repairs is curing. The first is a support device I named the Stalactijack. This is a spring-loaded PVC jack that is easily set up to support a repaired stalactite. I made it from a 2' long, 1" PVC pipe. I drilled six 1/4" holes 2" apart to hold a 2" stainless steel bolt with a wing nut to keep the 40-pound test spring in place. I then use a 2' long, 1/2" PVC pipe that sits atop the spring as a piston. I used a variety of sizes of PVC caps, attached with a stainless-steel screw to a 1/2" PVC cap that attaches to the top of the PVC piston. This way, I can easily change the cap to hold a variety of stalactite sizes.



Cut-away view of the spring-loaded Stalactijack. Photo by Mike Mansur.



L to R: Mike, Ellen Trautner, and Minori measuring how long a Stalactijack needs to be to reattach the formation piece in Minori's hand. Photo by Todd Roberts.



Mike and Knutt positioning a Stalactijack under a repair. Note in the upper left the broken formations we have not found matches to.

Photo by Todd Roberts.



Building the spring-loaded adjustable Stalactijacks on my tailgate. Photos by Mike Mansur.



Different sized caps to use on the piston end of the Stalactijack to fit most sizes of stalactites.



Different Stalactijacks I have created. The lower one is a screw-style I used for a 32-pound formation repair in the Big Room of Carlsbad Caverns. I used a $\frac{3}{4}$ " all thread for the jackshaft. The horseshoe-shaped spring-loaded one is to put horizontal pressure as well as upward force. I used this on a stalactite break on a sloped ceiling. Photo by Mike Mansur.



Our Lake Room worksite before and after the repairs were completed and Stalactijacks were placed.
Photos by Todd Roberts.

My next invention is the Speleoclamp. It holds a formation tightly in place while we drill holes for the placement of stainless-steel pins to provide rigidity to the epoxied joint. I needed a means of supporting the repaired formations while the epoxy set, and to hold the formation tightly while I drilled the holes to place stainless steel pins for joint reinforcement. I invented and fabricated a device that would hold these formations under various cave conditions. I decided to use $\frac{1}{2}$ " PVC pipe to make a 24" X 24" X 18" high clamp. I glued the pieces together at the top tier, but left the lower tiers unglued so I could add height if necessary. I used $\frac{3}{4}$ " PVC "T" s and piping to make sliding rails to serve as the clamp. I drilled $\frac{3}{8}$ " holes on these pieces to then install $\frac{3}{8}$ " all thread, and used $\frac{3}{8}$ " nuts and wing nuts to allow me to clamp the formation in place. I also added $\frac{3}{4}$ " foam pipe insulation to serve as a cushion on the rails to prevent possible damage to the formation. I made this device on September 12, 2018.



The Speleoclamp in use in Carlsbad Caverns. Photo by Todd Roberts.

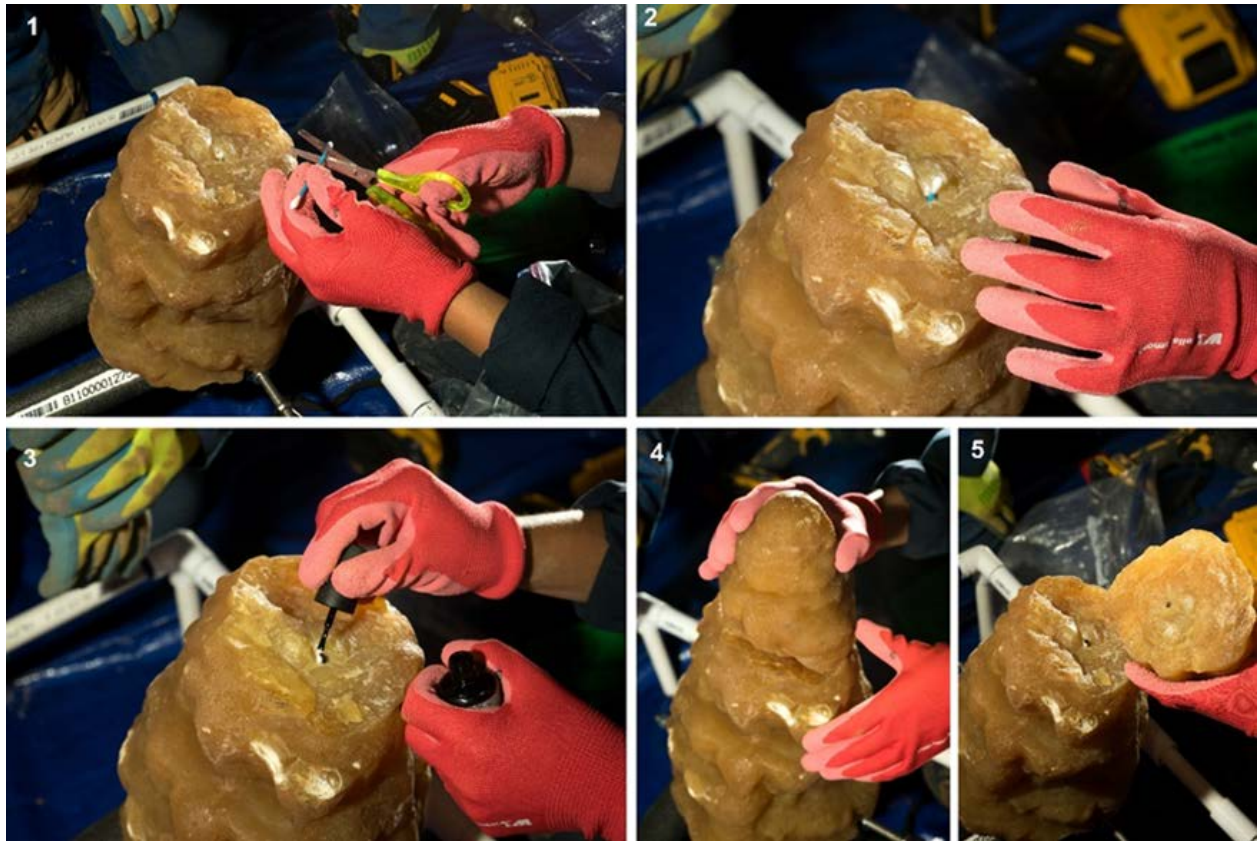


Mike assembling the Speleoclamp to hold the formation pieces while they are being drilled.
Photo by Todd Roberts.



Mike drilling a hole in the base of a large stalagmite that is being held in place by the Speleclamp. A 3/8" stainless steel reinforcing pin will be used to connect the upper piece of the stalagmite.
Photo by Todd Roberts

We had been using Sharpies with the ends cut off (around \$1.50 each) to mark corresponding holes in the formation joint to be drilled. This became quite expensive in caves like Cottonwood, where we have already epoxied and repaired over 220 joints. I was standing in Family Dollar and saw some Q-tips. I thought that would be a much less expensive means of marking the drill holes, so I bought some black nail polish to use. We tried this for the first time in Ft. Stanton, and it worked like a charm! The Q-tips can be easily cut to length and placed into the lower drill hole. We then put a drop of nail polish on the Q-tip, and put the two formation pieces together. The upper formation piece now had a mark to center the drill bit.



Repairing a stalagmite with the nail polish method and the Speleoclamp in the Lake Room.
Photos by Todd Roberts.

The third invention is the Speleocup. It is a PVC cap with two stainless steel screws or aluminum wire that we connect with rubber bands to a stainless-steel clamp attached to the stalactite base.



A Speleocup in use. Photo by Mike Mansur



Parts to make my Speleocups. Photo by Mike Mansur.



Todd Roberts placing a Speleocup on a stalactite repair in Cottonwood Cave. Photo by Mike Mansur.

The fourth invention is the Speleorack. It is used for firmly holding formations that have been epoxied together in a vertical position. It can hold up to 40 formations at one time. I used ½" PVC and 3" zinc-plated screws to hold the rubber bands, which in turn secure the repaired formations to the Speleorack.



The completed Speleorack. Photo by Mike Mansur.



The new Speleorack holding a repaired stalactite. Photo by Todd Roberts.



Knutt Peterson cleaning formations before the repairs. All of the Lake Room formations are mud-covered and must be washed by hand before being matched with their base or epoxied.
Photo by Todd Roberts.



Fully loaded Speleorack and Speleoclamp in foreground in Cottonwood Cave, with Stalactijacks and Speleocup in background. Photo by Mike Mansur.



Building the Speleorack on my tailgate.



Adding the 3" zinc-plated screws two inches apart onto the Speleorack. I ended up placing them onto the back side of the device as well due to a large number of formation repairs in Cottonwood Cave.

Photos by Mike Mansur.

The last invention I show here is the Speleorake. It is a tool for retrieving broken formations out of pools. It comes in two varieties (shown below).



The all-PVC Speleorake.



The PVC and stainless steel Speleorake. Photos by Mike Mansur.



Carrin doing what we have named Speleofishing using the Speleorake in Cottonwood Cave.
Photo by Mike Mansur.



Our staging area in the Ft. Stanton Cave Lake Room, with Stalactijacks, Speleorack, Speleocup, Speleoclamp, and two collapsible pails we use for cleaning mud off broken formations. This is how we have left our work area until we return next year after the bat hibernation period from November 1 to mid-April. Photo below by Mike Mansur.



Group photo in the Ft. Stanton Cave Lake Room for Public Lands Day. L to R: Mike Mansur, Todd Roberts, Minori Yoshida, and Carrin Rich. Note the Stalactijacks, Speleorack, and Todd's photographic prints of the broken ends in the lower right corner. Photo by Mike Mansur.

In conclusion, the special tools described above allow us to more easily do our formation repairs and restoration work. These devices can easily be constructed at little cost by anyone wanting to do take the time to build them. I have purchased all my materials from Home Depot and smaller hardware stores. Since these materials are cave-safe, made from clean, uncemented Schedule 40 PVC, stainless steel bolts, washers, all thread, wing nuts, galvanized springs, and zinc plated screws they can be left in the cave between trips.

I urge anyone who wants to do formation repair and restoration work to try it. The caves will benefit and those who visit them will be grateful to see these formations in their natural state!

I want to sincerely thank Carrin Rich, Knutt Peterson, and Pete Lindsley for their help in editing this article.

If anyone wants to contact me for more information at my e-mail address, please feel free to do so.

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