Installation of a Long-Term Instrumentation Network in the Omega Cave System

May 14-28, 2014

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Powell Mountain Karst Preserve
Wise County, VA

Wednesday-Thursday, May 14-15, 2014

After 1,220 miles and 2 days of driving, I finally reached Wise County in early afternoon on Thursday. Before driving up to the PMKP, I stopped at Home Depot in Kingsport and purchased the first of many batches of hydraulic cement (20 pounds), as well as Portland cement (94 pounds), additional tools, and general supplies. I reached the PMKP soon after some heavy rain stopped and right behind Phil Lucas, Mark Hodge, and Maret Maxwell; all three of whom were planning to dig in Solomon's Seal and Franklin Pit for a few days. The four of us removed the gate from the culvert at Solomon's Seal so that the cave would be ready for digging the next day.

Later in the evening, Matt Covington, Matija Perne, Katarina Kosič, Joe Myre, and Evan Thaler arrived from Arkansas, and Mike Ficco, Moly Lucier, and Philip Schuchardt arrived from Blacksburg.

Friday, May 16, 2014

A sunny and damp morning greeted us as we ate breakfast and started preparing for a day underground. The first order of business was to start packing supplies, gear, and instruments to be hauled into the cave. We spent several hours packaging cement in double gallon zippered freezer bags, cutting stainless steel reinforcing bars, wrapping foam around instrument cables, assembling kits with batteries, connectors, communication cables, stainless bolts, PVC pipes, stainless conduit clamps, Mylar party balloons, zip-ties, duct tape, silicone caulk, and a hundred other small but critically important items. Joe, Evan, and Katarina also made a grocery run.

By 2:00 PM we were finally ready for the first haul trip into the Blowing Entrance (the lower entrance to the system), with a plan for an advance group (Mike, Katarina, Evan, Joe, and Molly) to haul supplies all the way down to the intersection with the main trunk passage (The Potential Well Junction), while Matt, Matija, and I would haul more supplies, the hammer drill, and more tools and hardware down to the Rotunda Room where we anticipated installing the first weir in the entrance stream. The Rotunda Room is at the point where the upper level dry Bronchial Tubes drop back down to stream level.

The plan was delayed when we realized that sometime during the past couple months several large rocks had fallen off the overhanging ledge at the top of the entrance shaft. Unfortunately, one very large rock was still hanging there, directly over the shaft, and wiggled when Mike

prodded it with a pry bar. Loose as it seemed, it stubbornly refused to fall. After a couple hours of hard work, Mike called for the drill and some other tools. The rock finally submitted and we were all able to enter the cave between 4:00 and 5:00 PM.

When Matt, Matija, and I reached the Rotunda Room we unpacked and stashed gear and then set to work finding the best site for our first weir. In short order we found a site at the top of a small riffle series about 15m upstream from the Rotunda Room (Figure 1). We debated about design for a little bit and finally decided to simply cut a weir out of a solid sheet of stainless and remove some rock so it would fit neatly into the channel. With measurements made, we headed back to the entrance and exited just before the advance crew. Later in the evening, Mike Futrell arrived and Molly left for Blacksburg.

Figure 1. Matt and Benjamin unpack gear in The Rotunda Room. Photo: Matija Perne

The Solomon's Seal crew reported that they made some decent progress forward, but that the way on still required digging. Mark agreed to stop at the local hardware store the next morning and pick up another 20 pounds of hydraulic cement and two 80 pound bags of mortar mix.

Saturday, May 17, 2014

We spent the morning working with metal: cutting out a V-notch weir for the Rotunda Room site from a sheet of stainless steel (Figure 2), sawing 3/8" stainless steel rods into 12" lengths, and cutting stainless threaded rod into 3" lengths. Then we spent more time packaging hydraulic cement and mortar mix, stainless weir crests, miscellaneous tools and hardware, and cables and instruments. These loads were destined for two weir sites in the downstream end of the cave.

Figure 2. Our first weir cut from a sheet of stainless steel. We decided on a 60-degree V-notch because discharge in the Blowing entrance passage is often very low and a narrow angle gives better measurements under low flow conditions. Photo: Matt Covington.

By the time we got into the cave it was already 2:00 pm. Mike Futrell, Mike Ficco, Philip, Joe, Evan, and Katarina all hauled heavy loads downstream to the Orange Mammary tributary. Matt, Matija, and I hauled supplies to the Rotunda Room and finished the first stage of weir installation. The methods we used turned out to work very well and were used for the rest of the trip. This was good, because up to that point, our plans were just that; hypothetical plans about how we thought things would work! The first step was to figure out how the weir crest would be arranged in the passage. In this case, we had already decided where it would be, and had pre-cut a weir, so the main job was to notch the walls of the stream channel so it would fit (Figures 3 and 4). A PVC pipe was set in the low point of the channel and used to carry water beneath the weir during installation. In the future, the same pipe will allow us to drain and maintain the site.

Once the basic weir structure was roughed in, we used hydraulic (quick-set) cement to build a low dam around the PVC pipe and direct all flow through the pipe. Hydraulic cement has a set time of a few minutes, so it can be mixed until it reaches a putty-like consistency (usually in only 2-4 minutes) and then used underwater or directly in flowing water without being washed away. After it reaches the putty stage, it is only workable for another 30 seconds or so before becoming too hard. The redirection of flow through the PVC pipe allowed us to then work with cement

Figures 3, 4 and 5. Pre (top left) and post-wall modification (top right) at the Rotunda Room weir. A notch was cut into the walls using a hammer drill, and stainless reinforcing rods were set into holes drilled into the floor. The 2" PVC pipe is designed to carry water under the weir during installation, and to allow us to drain and maintain the weir in the future. Bottom: weir after hydraulic cementing is finished and cement and rock phase begins. Photos: Matija Perne.

Figures 6 and 7. On the left, the weir is approximately 50% complete. Rock and cement are being built up on the downstream side of the weir to stabilize and reinforce the structure against high flows. On the right is the complete weir structure prior to plugging the PVC pipe and filling the dam with water. Flat rocks and cement have been used to brace the weir and create a steep and smooth downstream face below the sharp stainless weir crest. The housing for the instrument can be seen bolted to the wall in the background. Photos: Matija Perne.

mixed on-site (Portland cement, with sand and gravel from the cave) to build additional reinforcing stone and cement around the weir (Figures 5, 6 and 7) without the cement washing away. The Portland cement mix required 24 hours to set to a point where we were comfortable with it holding water pressure behind the dam after the PVC pipe was plugged so, for most of the weirs, this meant that we built the main structure on one day and returned the next day to cap the PVC pipe and finish setting up the instruments and data loggers.

By the time we finished the Rotunda Room weir construction, the advance crew returned from their adventures hauling cement and gear downstream. They were all smiles and Joe, Evan, and Katarina really enjoyed seeing a portion of the main cave for the first time. Everyone gathered in the Rotunda Room for snacks and a photo op. (Figure 8). J.R Skok arrived in the evening and participated in campfire festivities after we all got out of the cave.

Figure 8. The crew gathered in The Rotunda Room for snacks and a break. L-R front: Benjamin Schwartz, Matt Covington, Mike Ficco, Philip Schuchardt, Matija Perne. L-R middle: Joe Myre, Mike Futrell. Top L-R: Evan Thaler, Katarina Kosič.

The Solomon's Seal crew again reported that they made some decent progress forward, but that some large loose rocks were causing concern. Maret, who was camping with us, reported that there was talk of moving digging efforts to a lead in Franklin Pit in favor of a more fun and scenic digging environment for the next day.

Sunday/Monday, May 18/19, 2014

The main objectives for the day were to haul more supplies to the Potential Well gear cache and head downstream for an extended day of weir building. Mike Ficco, Mike Futrell, and Philip Schuchardt headed home in the morning. Sometime early in the morning a local bear hound came through camp and started baying in front of Philip's tent. I slept through all the entertaining bits, but at least the dog didn't pee on anyone's gear (it was probably the same dog that peed on Mike Futrell's gear on a trip earlier in the year). I got up early and went to the Lowes in Wise to buy another 80 pounds of hydraulic cement and some more drill bits.

Joe, Evan, J.R., Matt, Matija, and I headed in around 1:30 pm. On the way into the cave, Matt and I stopped at the Rotunda Room site and set up the loggers. Unfortunately, the transducer seemed to be reporting unstable readings. After messing with it for a while, I went ahead and started it and determined that we would download the data another time and see how it looked before doing any further trouble shooting. For the expedition, I got a Rocky DB6 ruggedized

computer from Amrel, who gave us a ~50% discount on the price as a sponsorship. This was my first in-cave use of it and it worked flawlessly. The system is solid state and water and dust resistant (probably not a good idea to go swimming with it, though), and runs Windows 7 Pro, so I was able to install instrument-specific and other types of software before the trip.

With the instruments mostly running, the three of us headed into the cave to catch up with Joe, Matija, and Evan at Potential Well before heading deeper into the cave. J.R. hauled cement to the bottom of the entrance series and headed out, and Katarina took a rest day in camp.

When we reached the downstream gear stash (Figure 9) we unloaded and checked out potential weir sites. In the Orange Mammary tributary, finding a suitable site just above the waterfall into the main stream was easy. Finding a site in the main stream proved to be a bit trickier, but we finally settled on the one site that was our only real option. The site is ~120m downstream from the Orange Mammary tributary and is at the lower end of a long pool, just before the main stream drops into a narrow high-gradient canyon for several hundred meters.

We decided to try and install both weirs at the same time. Matt and Matija began work in the tributary (Figures 10 – 13) while Joe, Evan, and I started working on the main stream site (Figure 14). The main stream site turned out to be unsuitable for a V-notch weir, so we decided to build a small rectangular weir within a larger rectangular weir. Discharge at this site will be the largest anywhere in the cave system, so issues with a rectangular weir at low flow will be minimized.

Figure 9. Matt, Joe, and Evan behind part of the downstream gear/cement stash before weir construction. Photo: Matija Perne

Previous page: **Figures 10 through 13.** Matt Covington at the Orange Mammary weir. CW from top left: layout, construction begins, progress, and nearing completion. Photos: Matija Perne.

Figure 14. Benjamin Schwartz and Matt Covington at the downstream weir. The weir is installed in an area where the main stream drops off a thick lens of siltstone and dives into a high-gradient canyon. After water levels reach the top of the internal rectangle, then it will flow over the broad crested wings. The water beneath Benjamin is at least a meter deep in a combination of dissolutional and scour features that have connected to form a deep canal. Photo: Matija Perne.

For the next several hours we worked with efficiency and determination. At the downstream site the rapids made a lot of noise, so the three of us simply worked without verbal communication. Joe and Evan redefined the meaning of ‘pack mule’ by hauling packs full of flat rocks from a site several hundred meters upstream (there were no loose rocks at the weir site), in addition to dry-mixing concrete gallon-bucket-by-bucket so I could mix it with water and use it to build the structure. Once we developed a system, even though the day began to get very long, work proceeded slowly but smoothly. Finally satisfied that the weir structures were complete, we headed out of the cave and reached the surface after a fast three hours of travel.

We climbed out the entrance shaft at 10:00 am, after almost 21 hours underground, and were greeted by a sunny day and Katarina cooking us an endless supply of buckwheat pancakes that we slathered in butter, peanut butter, jelly, and/or syrup. Mmmmmmm!!!! After ‘breakfast’ and a short nap, we organized gear and supplies for the next day before enjoying campfire fellowship and Slovenian juniper schnapps.

Wil Orndorff and Steve LePera arrived later in the afternoon and joined our merry band of concrete haulers, and Bill Balfour, Carroll Bassett, and Ellen Koertge stopped by for a visit on their way to do some work in The Cedars of Lee County.

Phil, Maret, and Mark dug in Franklin Pit on both Sunday and Monday and reported good progress in a small lead that blows a massive amount of air. Unfortunately, they were heading home the next day without a breakthrough in either of the caves.

Tuesday, May 20, 2014

With a reasonably early start to the day, we split into two teams. Katarina, Matija, and I headed back downstream to finish the weirs there and start the instruments logging. Joe, Evan, Steve, and Wil took a big load of cement, gear, instruments, and supplies upstream with the goal of reaching The Grad Master waterfall about 6 hours from the entrance. J.R. hauled another big load of hydraulic cement down to a staging point at The Rotunda Room and Matt took the day off to rest and work on a manuscript with a looming deadline.

The Grad Master crew was able to use the working map and my notes to successfully find their way upstream. They reached a point a few hundred feet below the Grad Master where a rope drops out of Aster Crickets and assumed this was the rope where they were supposed to leave the gear. Talking with them later, it sounded like they had a great trip and really enjoyed seeing more of the main stream trunk.

Katarina, Matija, and I headed in last, stopping to collect several diplurans from near the bottom of the entrance series, and reached the downstream sites in about three hours. The first thing we did was check the concrete, which had all set very nicely, and begin installing the instruments at the Orange Mammary weir (Figure 15). Each instrument is housed in a 2.5 cm diameter section of PVC pipe bolted to the wall upstream of the weir using stainless bolts and stainless conduit clamps. A stainless 45 cm ruler is also attached to the wall and acts as a staff gauge for directly reading water levels behind the weir. Once the instrument is set up, we cap the PVC drain pipe(s) and let the weir dam fill; recording the pressure transducer and staff gauge readings at the exact moment when the water level was horizontal with the bottom of the v-notch in the weir (Figure 16). We then waited for the pressure transducer readings to stabilize before recording another measurement from both transducer and staff gauge. This records the full flow depth of water over the weir, which will allow us to calculate a starting discharge at the site.

The next and final step was to start the instrument logging and set up the external power that will keep it running for the next year, or longer if needed. Although the instruments (TruBlue 585 CTD loggers manufactured by Measurement Specialties) have an internal-power battery that should keep them running for 3-5 years, we don’t want to use this battery because there is no way to replace it. Instead, by using an external power source, we can bypass the internal battery and the instrument will only use it in case of failure with the external source. I wired up two 6-AA battery packs in parallel with Schotky barrier diodes so that the system has triple redundancy in power. If one of the external packs fails, the other one continues to provide power. If they both fail, then the internal battery kicks in. Our hope is that with this setup we will not have any issues

Figures 15 and 16. Katarina and Benjamin install the instrumentation (pressure and staff gauge upstream from the weir (Left) and Katarina keeps a close eye on the staff gauge as the water level builds and approaches the bottom of the notch in the weir (Right). Photos: Matija Perne.

with missing data due to battery failures! Additionally, the head engineer at Measurement Specialties custom modified the internal circuitry for us to reduce the maintenance load (between measurements) to as little as possible, which should extend the potential battery life significantly. In theory, we could probably let the instruments run for at least 2 years.

After we finished installing the CTD (Conductivity, Temperature, Depth) logger, we also set up the Temperature/Relative Humidity (T/RH) logger (Onset) that is paired with each weir site, as well as on the surface at each entrance (Blowing and LCCC), and inside the entrances where it is paired with a Barometric Pressure logger (also by Measurement Specialties). The idea is that air T/RH and barometric pressure may help us understand more about how the in-cave airflow changes on a seasonal basis, as well as how it responds to changes in water temperature.

Next on the list was to start the instrument at the Downstream Main Stream site (Figure 17). This instrument gave me some communication issues until I realized that the Serial-USB converter wasn't switched to the right position. Fortunately it was a quick fix that just left me feeling silly. As with the other sites, once the instrument was set up and logging, we encased the end of the instrument cable, communication cables, desiccant, and the battery packs in a mylar balloon

Figure 17. Benjamin and Katarina at the Downstream Main Stream weir site as the CTD instrument is programmed to start logging at 10-minute intervals. Photo: Matija Perne.

Figure 18. Happy Birthday, Spiderman! Benjamin throws spider silk at the Downstream Main Stream weir site before the cables and batteries are sealed inside the mylar balloon. The small white object behind the cables is the T/RH logger. Photo: Matija Perne.

(Figures 18 and 19). This balloon allows the vented cable end to remain sensitive to tiny changes in barometric pressure (as the balloon expands or contracts), while keeping moisture from migrating down the vent-tube in the cable. The instruments are vented so that the pressure transducer can compensate for atmospheric pressure at each site automatically, rather than reading an absolute pressure, which includes both water depth and atmospheric pressure. Although there is a built-in desiccant pack on the cable end, the instruments were not designed to operate continuously in 100% humidity for longer than the internal battery life.

With both of the sites completed and all the instruments logging, we packed up several very heavy packs plus the drill pack and hauled all the remaining supplies and gear upstream to Potential Well. The next time we see these two sites will be in 2015. Along the way, we collected several more water samples and T/pH/SC measurements and looked for aquatic invertebrates, finding two amphipods and the largest cave-adapted flatworm I've ever seen near station B5.

We were all out of the cave by late evening and again enjoyed a beautiful evening around the campfire. Once again, Joe and crew had cooked one of the amazing meals that seemed to magically appear every evening. I only managed to wash dishes a twice throughout the expedition, so I felt a bit guilty about eating so well! Dave Socky arrived later in the afternoon.

Figure 19. Final measurements and sealing are done, and the site is ready to go until 2015. Then we get to see how well all this really works! Photo: Matija Perne.

Wednesday, May 21, 2014

Today wound up being a relatively short day for most folks. After a relaxed morning that included a group picture (Figure 20), we split into three underground crews and a surface crew.

Wil Orndorff made a pilgrimage to the Lowes in Wise and purchased the last 80 pounds of hydraulic cement they had in stock, as well as a few other odds and ends.

Steve LePera and I made a trip to the bottom of the entrance series and changed some rigging on the 125' pit. It now has a redirect near the top and a rebelay about 80' down. The redirect pulls the rope well away from all rub points while the rebelay moves cavers and the rope away from

Figure 20. Group shot on the morning of May 21, 2014. Front row, L-R: Matija Perne, Katarina Kosič, Dave Socky. Back row, L-R: Evan Thaler, Joe Myre, Benjamin Schwartz, Matt Covington, Wil Orndorff, Steve LePera, J.R. Skok. Photo: Matija Perne.

waterfall spray (especially during high water) and allows two cavers to be on rope and climbing at the same time. Once we finished the rigging, we moved back up to the Rotunda Room where I downloaded a few days' worth of data and determined that, indeed, there was something wrong with either the instrument or the cable. With some troubleshooting, I determined that it was almost certainly the instrument, and we replaced it with a new one that appears to be working just fine. Moving on, we also installed a barometric pressure/temperature logger inside the cave and near the bottom of the Blowing entrance pit, paired with a T/RH logger. This instrument will record changes in temperature, atmospheric pressure, and relative humidity that will allow us to determine when airflow changes directions throughout the year.

Matt and Dave Socky headed back downstream to install some erosion meters that we had not had time to install on the previous trip. These consist of 3/8" stainless bolt pairs set in sections of bedrock channel and a 45cm length of stainless slotted channel. The bolts have a pair of nuts locked together and set with Loctite that serve as a reference point for the channel to sit on, where it is held in place with another nut and washers. The depth to bedrock from the top rail of the channel is then measured at either end of each slot using a depth micrometer, for a total of 14 measurements per bolt pair. In several places bolts are set in lines across the channel and up the wall so that the channel can simply be moved from segment to segment. The idea is that we will be able to come back each year and repeat the measurements to determine a modern rate of

incision along the main stream in various bedrock channel lithologies; limestone, dolostone, sandstone, and siltstone.

Joe, Evan, and Katarina made a second haul trip to The Grad Master and moved as much gear from the previous caches forward as they could.

Matija and J.R. stayed in camp and kept the friendly bear hound from peeing on our gear.

After some of us got out of the cave later in the evening, a storm system approached from the west. Thanks to the miracle of smart phones, we learned that the storm was moving at 95-110 kph with potential for dangerous winds. Fearing a derecho-like storm might blow trees down on us, we tied or anchored down everything we could and took shelter in Parsons Cave. Fortunately, the predicted winds didn't materialize, though the thunder and lightning was impressive from deep in the cave, and when we emerged we found our campsite inundated with 10cm of floodwater. Even though a couple tents were actually floating, they had waterproof bottoms and there were no disasters. Matija and others worked on waterworks for a while and directed much of the floodwater into two tiny sinkholes between some of the tents and kitchen area.

Thursday, May 22, 2014

It was time for me to take a rest day, and everyone else was either tired or had to leave, so we spent the day relaxing, eating, relaxing some more, eating some more, and preparing for a very long trip upstream the next day. Wil, Steve, Dave, and Evan all left in the morning.

Friday/Saturday, May 23/24, 2014

We expected this trip to be the longest of the expedition, and we planned to build the upstream-most weir at the Blonde Moments tributary in one trip (about 8 hours travel upstream from the Blowing entrance), and get as much done as possible on a weir in the main stream just below The Grad Master. Because Blonde Moments is so far upstream, we hoped to avoid returning for a second visit by using a lot more hydraulic cement than normal, get the weir operational, and then finish the higher parts with cement that would set up without being in contact with flowing water.

Matt, Joe, Matija, Katarina, and I all entered around noon and began working our way into the cave. I was lugging a full camp duffel and everyone else had big packs with room in them to pick up more supplies at the cache points. Unfortunately, by the time we reached the Rotunda Room, Katarina was feeling really sick. Matija headed back out to the entrance drop with her to make sure she made it out ok and then caught up with the rest of us at the Potential Well cache where we reorganized, stuffed our packs to the brim, and picked up critical supplies.

The trip upstream to The Grad Master site was uneventful and we added to the already huge pile of supplies before reorganizing again and packing the supplies needed for the Blonde Moments site. From there it was a long, slow, slog upstream for several more hours, carrying even heavier packs, until we finally reached the site. In short order we decided on a suitable spot just 20-30 m into the canyon section of the tributary and began setting things up. Matt set up his new GoPro camera on a tripod and captured a nice time-series of pictures through most of the construction

Figures 21-22. Top: Benjamin and Matt set the PVC pipe in place in Blonde Moments. Bottom: Benjamin tests the weir crest configuration. Photos: Matt Covington.

Figures 23-24. Top: Benjamin uses the hammer drill to create a wall-notch to brace and locate the weir crest. Bottom: Benjamin and Matija work on weir construction. Photos: Matt Covington.

Figure 25. Weir construction is ~50% complete. This is one of the last pictures taken before the camera and light batteries died. Photo: Matt Covington.

(Figures 21- 25). Unfortunately, the batteries died before it was finished, but it makes a neat stop-motion video! While I did most of the concrete and stone work, Matija and Joe brought me rocks and pre-mixed dry cement with local sand and gravel, and Matt worked on installing the instrumentation and erosion meters. We had brought a small stove and powdered Tang mix, and several times a cup of hot Tang was made and passed around. It was an amazing lift to our spirits to sip a hot drink! Working in this passage was fairly miserable because the water was relatively cold (~8.5 C) and the wind was blowing strongly. Figure 23 captures the wind by showing how the dust from the hammer drill is being blown downstream as I worked on notching the wall.

I don't recall what time it was when the weir was finished, but after the last bucket of concrete had been mixed and the last rock placed, we set up and programed the instrumentation, collected water samples from the main stream and the Blonde Moments Tributary, cleaned up and packed all the remaining supplies and gear, had one last cup of hot Tang, and headed back downstream towards The Grad Master. We stopped on the way back and took a break where we had set up a T/RH logger (on our way upstream earlier in the day) at the old camp site near station B160.

At The Grad Master site, we unloaded packs and spent some time choosing a final weir site before diving right into the construction of a second weir. Because of the dead camera batteries, we don't have photos during initial construction, but it proceeded as smoothly and slowly as always! Matt also installed more erosion meters in several locations in sandstone and dolostone near the weir.

Sometime around 10:00 am on Saturday, Matija and Joe began heading for the entrance while Matt and I continued mixing cement and working on the weir. The main objective was to get it to the point where we had cement high enough that it could be plugged on the next trip, even if the higher parts still needed to be constructed. We accomplished this and began our own slog out of the cave sometime between 11:00 and noon. Along the way we stopped and collected a couple more water samples. At 4:00 pm on Saturday afternoon, after 28 hours of mixing concrete and caving, Matt and I climbed out the entrance shaft. Katarina was feeling somewhat better again and had mixed up yet another amazing batch of buckwheat pancakes that just kept coming off the stove. A couple hours later, Joe again mixed up an amazing meal. We all went to bed early, knowing that we still needed to return to the Grad Master site the next day and haul all the tools and gear back out of the cave on a final push to finish the installation and clean up the cave.

Mike Ficco, Mike Futrell, and Philip Schuchardt arrived on Friday evening and had, along with J.R., entered the cave Saturday morning to continue an aid climb in the Wire Whisperer section of the cave. They returned about midnight and reported on Sunday morning that they had finished the climb, explored and surveyed ~150m of nice new passage, left a couple good leads, and had strong airflow moving in a couple different directions.

Sunday, May 25, 2014

With a good night of sleep behind us, Matt, Matija, and I headed back into the cave to finish the weir at The Grad Master. Without heavy loads, we moved fast and reached the site in a little over 3 hours and dove right into continuing the work, starting with installing more stainless reinforcing bars (Figure 26). Matt installed the instrumentation (Figure 27) and finished erosion meter installations (Figure 28) while Matija and I mixed and mixed and mixed….

I also spent some time removing a large amount of rock from just downstream of the weir so there would be less interference with the water falling over the weir crest during flood events. It is amazing what you can do with a hammer and chisel and a hammer drill! The weir crest was also bolted directly to the bedrock in several places, notched into one wall, and braced with stainless struts bolted and cemented to the bedrock (Figure 29 and 30). Out of the five weirs we installed this year, I think this is probably our crowning achievement. I expect it to withstand major floods with no problem at all!

One of the larger chunks of rocks that I removed wound up being ideal for working (by ‘flint knapping’ and some fancy chisel work) into a piece that I could use to extend the sharp weir crest on one side of the channel (Figure 30). This saved us a lot of time and worked perfectly!

In only 5 hours of additional work, we finished the weir construction, set up and started the instruments (Figures 31-33), packed up all the tools and gear, and headed out of the cave. On the way we installed more erosion meters in a limestone bedrock channel and picked up additional gear from Potential Well. The only things left in the cave at this point are a few bags of Portland and hydraulic cement at The Grad Master site (sealed in trash bags), a piece of PVC pipe for the instrument at the Blonde Moments site, and a few stainless rods. These are supplies that can be used in 2015 to make repairs in the event that damage occurs or modifications need to be made to the weirs. We also left a few bags of mortar mix (similarly sealed) at Potential Well.

Figures 26 - 28. Top left: Construction continues during the second day at The Grad Master. Top right: Matt installs instrumentation at the same site. Bottom: Matt installs an erosion meter bolt pair in a dolostone portion of the channel downstream from the weir. Photos: Matija Perne.

Figures 29 and 30. Top: The Grad Master weir is going nowhere! Wall-notches, bolted to bedrock, rebar, braces, and concrete! Bottom: The finished product. The upper left portion of the crest is mostly made from a piece of bedrock that was removed from below the weir, and that Benjamin worked into the proper shape with a hammer. At this and all other weirs, detailed measurements were made to develop a complete channel cross-section in the event that water levels rise above the ends of the stainless crests during a flood. Photos: Matija Perne.

Figures 31-33. Top left: Instrument installed. Top right: The instruments are started and initial readings made. Bottom: Matt reads the ‘weir-full’ staff gage measurement. Photos: Matija Perne.

With our packs stuffed and overflowing, we made our way back out of the cave in good time and reached the surface after only a 12.5 hour trip. Once again, Joe, Katarina, and J.R. outdid themselves by having an amazing dinner waiting for us!

Monday, May 26, 2014

This was to be our last day of work on the expedition and we only had a few tasks planned. The main objectives for the day were to install the barometric pressure/temperature and T/RH loggers inside the LCCC entrance (the upper entrance to the system), and install the T/RH loggers on the surface at both entrances. In order to protect the instruments from the weather and potential vandals, I built some small PVC housings and spray-painted them with tan and green leaf patterns. These could then be bolted in a tree near each entrance using a stainless lag bolt.

The morning started off well and Matt, Matija, J.R., and I drove up to High Knob and out to the parking area where we hike down to the LCCC entrance. We were about 2/3 the way down the mountain when I realized that I had forgotten to pack the instrument cable. Arghhhh!!!! Matija was already carrying all the gear (thanks again, Matija!) in exchange for not having to enter the cave, so I ran (ok, trotted and walked fast) back up to the truck for the cable while the others continued down to the entrance. 30 minutes later, and covered in sweat, I met them at the entrance and we prepared to actually install an instrument!

The locks opened without much difficulty. For preventative maintenance we sprayed a liberal amount of WD-40 on them and locked/unlocked them several times. Matt and I entered the cave and quickly reached the first intersection in the entrance series; about half way to the 30m pit. In about 30 minutes, we installed the instruments on the wall at this intersection and started them logging (Figure 34). The sites near the entrances are actually the sites I'm most concerned about having problems with because they are within reach of animals, like packrats, that we have seen in the cave every once in a while. I just hope they don't like the taste of expensive cables!

Back on the surface, we made short work of installing the T/RH sensor outside the entrance (Figure 35) and then enjoyed the slow walk back up the steep mountainside through the lush green forest.

We arrived back at camp in time to meet Mike Ficco and Philip Schuchardt, who had spent the last two days rock climbing. We loaded them up with gear that needed to return to Blacksburg, and some of the trash. They left late in the afternoon and the rest of us installed the final T/RH logger in a tree near the Blowing entrance shaft, which completed the work part of the expedition. We spent the evening playing with balloons in the cool wind blowing up out of the Blowing entrance shaft, eating, enjoying the campfire, and packing up most of camp in preparation for an early morning departure the next day.

Figures 34 and 35. Left: Nearly done with installing the barometric pressure/temperature and T/RH instruments inside the LCCC entrance. Photo: Matt Covington. Right: T/RH instrument installation on the north side of a tree outside the cave. Photo: Matija Perne.

Tuesday, May 27, 2014

Everything went as planned and we drove down off Powell Mountain at 7:00 am. Matt, Matija, Katarina, and Joe started a long day-trip to reach Arkansas that night and I started my two-day journey to drive back to TX.

Wrap-up and Thanks!

Thanks to the fun, strong, and unbelievably enthusiastic crew of cavers that help during all or parts of this two-week expedition, we were able to accomplish an absolutely amazing amount of work. We installed 5 of the 7 weirs that Matt and I planned in our original research proposal to the Cave Conservancy of The Virginias, including the largest and hardest to build weirs that are farthest from an entrance. Cumulatively, the expedition hauled close to 225 kg (500 pounds) of cement products into the cave, and uncountable amounts of gear, tools, and other supplies that were either used in the weirs or were needed to build them. Many of these items were carried into, back and forth, and back out of the cave multiple times (drills, drill batteries, hammers and chisels, all the trash, cameras and computers, etc. – the list is nearly endless). Every single item or bag of cement that was moved supported the project objectives in a very tangible way and allowed us to accomplish what most people might describe as a nearly impossible task.

I wish there were some way to sufficiently thank everyone involved (other than with the two coolers full of Texas beers), but I don't really think there is. Rest assured that Matt and I will acknowledge everyone who helped with this incredible effort in the publications that we plan to write using data from this project. We also hope that all these efforts pay off in the form of future grant proposals that can be used to fund expeditions a little better. It sure would be nice to have travel and food covered for everyone that helps out.

So, with heartfelt sincerity, thank you all again for everything you did to help with this project!

Benjamin and Matt

Bonus picture #1: A rapidly disappearing chocolate, chocolate, chocolate, chocolate raspberry cake that Mike Ficco made and brought down. It was soooo good! Photo: Matija Perne.

Bonus picture #2: Our very nice campsite on PMKP. Photo: Matija Perne.

Solomon's Seal Cave and Franklin Pit Blowhole

May 16-19, 2014

Reports By: Phil Lucas

Powell Mountain Karst Preserve - Wise County, VA

Solomon Seal Cave: May 16, 17, 2014

Participants: Phil Lucas, Mark Hodge, Maret Maxwell

We extended the cave past the former "danger rocks" by installing 4x4 pressure treated wood shoring. This led to a tiny rain well complex about 20 feet deep. Two days of straw work was spent enlarging this interconnected dome. The air was determine to be coming from the below and more enlargement at the base of the rain well will be required to reach the fissures carrying the air. On the last straw shot two large slab rocks (part of the wall) tumbled out leaving the upper part of the wall with little support. To continue safely, shoring will be necessary.

Franklin Pit Bowhole: May 18, 19, 2014

Participants: Phil Lucas, Mark Hodge, Maret Maxwell

The blowhole is located about 30 feet down Franklin Pit on the large shelf. Along the north side of the shelf is a fissure originally located by the roaring sound of air blowing hard through a restriction in the fissure. After removing a shoulder of rock, the true nature of the tiny crack was revealed to be a couple cracks a few inches wide. Two days were spent using many straws to remove sufficient rock to provide a sufficient working area space to "chase" these cracks. About ten feet of progress reached a point where the two cracks had merged and the passage onward is fissure about 6 inches wide that continues horizontally. Progress beyond this point should become more rapid as the walls just need to be shaved back a few inches.