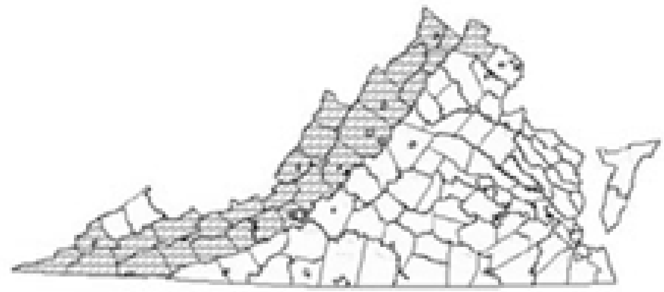
VIRGINIA CAVE OWNERS' NEWSLETTER



A publication of the Virginia Cave Board, Department of Conservation and Recreation No. 24, April 2012

Table of Contents

April 2012

Thanks to contributors: Babs Bodin, Dr. Dan Doctor, Thomas Lera, Judy Molnar, Wil Orndorff, and Meredith Hall Weberg

Hike the Karst Trail!

Getting out and or getting "in"—into a show cave or cave exhibit—is the underlying idea behind this year's theme for the annual celebration of **Virginia Cave Week**. This year Cave Week is April 22–28, 2012.

Dixie Caverns, Grand Caverns, and Shenandoah Caverns are all offering Cave Week discounts again this year. Ask for your Cave Week discount when buying tour tickets.

Get out or IN and learn about caves and karst in the Commonwealth!

Letter From the Former Chairman

by Thomas Lera

This is my last column, as I have come to the end of my five and a half years service as Chairman of the Virginia Cave Board. It has been both a pleasure and a privilege to serve in this office and to have met many of you at national, regional, and local events. I know there is still enormous goodwill and support out there for the Board to both represent you and lobby the State on your behalf.

I will not bore you with our accomplishments over the last five years. Rather I will stress the importance of having a strong board chairman, as it is the most strategic in the organization. We are fortunate to have Meredith Hall Weberg as the new Virginia Cave Board chairman. She is a true friend and I will work with her to achieve her goals for the Virginia Cave Board.

I know she will work closely with the State, National, regional, and local associations and groups, chair board meetings, and act as a spokesperson for the VCB to the community. Meredith will also guide fellow Board members in achieving consensus and unity, motivate them to carry out their projects, and stay informed on issues relating to the caves and karst.

This is your Board and I hope you all continue to support it and Meredith in the future as strongly as you did me in the past. I look forward to serving on the board and working with you all for many more years.

Chairman's Column

by Meredith Hall Weberg

Tom was too kind in his last column; I hope I can live up to his glowing words.

I was rather surprised to be asked to "run" for Virginia Cave Board (VCB) chairman, but also very honored that the rest of the Board thinks I will do a good job. I will do my best.

Already I have run a couple of meetings and written a couple of letters on behalf of the VCB, one hard and one easy. The hard letter was written by two of our Board member scientists and was one of the more difficult things I've ever edited. You must keep your reader in mind when writing and I could not understand some of how they phrased things. I think it turned out well because I had a lot of help; in fact, the gist of that letter is now VCB's policy on cleaning "lampenflora" (algae!) from show caves and is included elsewhere in this issue. The easy letter was a "thank-you" to the Blue Ridge Grotto, a cave club based in the Roanoke area, for its donation to VCB for our good work of helping YOU with your stewardship of our Commonwealth's caves.

VCB is, after all, dedicated to Virginia's cave landowners. Please contact us if you have questions, want information, or need our help with anything. We are here to help you take care of your cave(s).

I hope you enjoy reading the articles in this issue of the Virginia Cave Owners' Newsletter. I enjoyed editing them. You see, I am also the editor for VCB. I would love to hear from you in that capacity as well, especially with suggestions for articles or if you want to write an article yourselves! Maybe one of you cave owners out there has a unique story or situation related to owning a cave that you want to share with others.

What I'm trying to say is that the Virginia Cave Board exists to serve you, Virginia's owners of caves. Please let us know how we can help.

(The small graphic next to the article title is the cave map symbol for columns, speleothems that are formed when a stalactite grows down and a stalagmite grows up, and they meet in the middle.)

Determining the Age of a Cave

By Dr. Dan Doctor, Virginia Cave Board

"How old is the cave?" This question often comes to the mind of the curious cave visitor. It is not a simple question to answer, because caves can form over time spans of thousands, sometimes millions of years. What makes the question even more difficult to answer is the fact that it is impossible to provide a date on what is no longer there; a cave, after all, is mostly empty space. A slightly easier question to answer is, "What is the age range of this cave?" By dating the materials we find in caves, we can say with confidence that the cave is at least as old as the things found within it and must be younger than rocks that contain it.

In Virginia, most caves are formed within limestones that were deposited as marine sediment during the Paleozoic era of geologic time, between about 570 and 350 million years ago. Fossils and radiometrically dated volcanic ash beds sandwiched among the limestone layers provide direct evidence of the age of the rock layers, or strata. The sedimentary rock strata were later deformed during the building of Appalachian Mountains, which occurred approximately between 320 to 220 million years ago. Nearly all caves in Virginia show passages that follow fractures and folds that formed in response to the deformation associated with the mountain building, thus the caves are very likely younger than about 200 million years.

But how old is the space itself? The best we can do is determine a minimum age of a cave by determining the age of items within it. These items can include human artifacts, animal bones or other remains, and mineral or sediment deposits that lend themselves to dating by geochemical methods. When we are lucky enough to find such items in a cave, undisturbed and in their original place of rest or deposition, we can begin to piece together the history of the cave. Although human and animal artifacts are very useful, they usually only provide information on the most recent period of the cave's history, the time since the cave was open at the surface and accessible to entry. To go further back into geologic time, geochemical age-dating of mineral deposits is necessary.

This is a stalagmite from Grand Caverns. This photo shows the stalagmite sliced in half, illustrating the growth layering. The top has been dated to be 12,800 (+/- 100) years old and the bottom is 66,500 (+/- 500) years old. (dating by Dr. Yongli Gao, East Tennessee State University)

DATING SPELEOTHEMS

In order to directly measure the age of a speleothem (stalagmite, stalactite, or other mineral formation in a cave), geologists measure concentrations of radioactive elements and their decay product isotopes that are part of the chemical makeup of the mineral itself. Isotopes are atoms of a particular element that, because of different numbers of neutrons in their nucleus, have different atomic weights, or masses. Just like the weight of a person is measured in pounds or kilograms, the weight of an atom is the total sum of proton and neutrons in its nucleus, and this number is the atomic mass. For example, an atom of uranium-238 (or ^{238}U) has an atomic mass of 238, with 92 protons (which defines the atom as uranium) and 146 neutrons. If the nucleus of an atom is unstable, it will spontaneously give off some particle or amount of energy. This process is called radioactive decay.

When radioactive decay of an atom occurs, the initial atom does not simply disappear; rather, it changes into another isotope of that element, or into an isotope of another element.

As decay product isotopes build up in a mineral over time, the amount produced provides a record of how much time has passed. This is because radioactive elements decay over well-defined periods of time. The rate of radioactive decay is measured in half-lives, or the amount of time needed for half of the radioactive substance to decay away. The longer the half-life, the greater the age of the material that can be dated. For example, the radioactive isotope of carbon, carbon-14, has a half-life of 5270 years, and is useful for dating materials less than about 42,000 years old. Materials older than 42,000 years do not have enough carbon-14 remaining in order to provide a reliable age because it has decayed away over more than eight half-lives, at which time less than 0.39% (=0.5^8) of the original amount of carbon-14 will remain.

Although carbon-14 can be used to date relatively young speleothems, uranium is a radioactive element that is well-suited for dating older ones. Because uranium is soluble in water, it is incorporated into new minerals that grow out of the water that enters a cave. The decay product of uranium that is used to provide an age of the mineral deposit is the element thorium. Fortunately, thorium does not easily dissolve in water, so that there is almost no thorium in new layers of mineral growth. This allows very accurate age-dating of speleothems using the ratio of uranium to thorium present in the mineral. When the mineral initially crystallizes, it incorporates uranium but virtually no thorium. As time passes, uranium decays and thorium accumulates according to the balance of the decay rates of the radioactive isotopes. The key in this process is the 75,380 year half-life of thorium-230, which is itself radioactive, allowing for dating of deposits that are less than approximately 600,000 years old.

This photo is of the stalagmite as we found it, naturally toppled over, with new growth of a "fried egg" stalagmite in the spot it previously grew from. Taylor Burnham, a geology graduate student from East Tennessee State University, is shown.

CLIMATE INFORMATION FROM SPELEOTHEMS

Stalagmites that are shaped like broomsticks are generally slow-growing, with layer upon layer of calcite mineral added over long periods of time. These layers represent growth bands like tree rings and can sometimes show annual bands; however, the individual layers more often represent hundreds or even thousands of years. The rate of growth of a stalagmite can be determined by dating a large number of individual layers along the central growth axis and interpolating the distance between the ages. In this way, we are able to determine if a stalagmite has been growing particularly slowly or particularly quickly in different intervals. Periods of time when the stalagmite may have stopped growing altogether are also apparent. Such changes in stalagmite growth rates provide clues to the changes that may have taken place in the climate above the cave over time, with wet periods generally representing periods of more rapid speleothem growth.

But speleothems can provide much more detailed information about past climates. Because the calcite mineral is precipitated from water dripping into the cave, it contains a geochemical record of the composition of that water and in some cases can contain microscopic bubbles, or fluid inclusions, of the water itself. By determining the geochemical composition of the water from which a speleothem grew, geologists can surmise whether the past climate was warmer or colder and wetter or drier than that of today. Correlating such detailed records of past climate among several caves in different regions, as well as with records obtained from polar ice cores on land and deep ocean sediments, geologists reconstruct the changing climate of the Earth over hundreds of thousands of years with great accuracy. With this information, climate scientists are able to test computer models used to forecast future scenarios of climate change against predictions of past climates known from geologic data, partly obtained from caves.

An Update on White-Nose Syndrome in Virginia

By Wil Orndorff, DCR Karst Protection Coordinator

March 7, 2012

The winter of 2011–2 marked the fourth year that bats hibernating in Virginia's caves have been under attack from white-nose syndrome (WNS), a disease characterized by a white fungus on wings and/or muzzles of many affected bats and resulting in death rates of up to 90 percent in some affected bat species. Research published in the last year has verified that the fungus is the sole cause of WNS. The last two issues of the *Virginia Cave Owners' Newsletter* (Summer 2009 and Winter 2010) provided information on WNS and what actions cavers and cave owners might be able to take in order to slow its spread or lesson its effects.

Fortunately, not all cave bat species are equally affected by WNS. Most mortality to date in Virginia has been among little brown bats (*Myotis lucifugus*), tricolored bats (*Perimyotis subflavus*), and northern long-eared bats (*Myotis septentrionalis*). Unfortunately, little brown and tricolored bats are the two most common cave bat species in Virginia, so high mortality among these species has greatly reduced the total number of bats present in most caves. Death rates among WNS-susceptible eastern small-footed bats (*Myotis liebii*) are hard to estimate due to low observation rates. Although heavily impacted in the northeast, populations of the federally endangered Indiana bat (*Myotis sodalis*) in Virginia have to date experienced little apparent mortality from WNS. The federally endangered gray bat (*Myotis grisescens*), though closely related to the little brown bat, does not appear to be affected by WNS, nor do the big brown bat (*Eptesicus fuscus*) or the federally endangered Virginia big-eared bat (*Corynorhinus townsendii virginianus*). WNS has not observed to affect tree bat species.

In January 2012 at the Northeast Bat Working Group meeting in Pittsburgh, Rick Reynolds of the Virginia Department of Game and Inland Fisheries (DGIF) presented a summary of collaborative efforts with the Virginia Natural Heritage Program, Radford University, and National Speleological Society volunteers to study the impacts of WNS on Virginia's bat populations. To date, approximately 4,000 bats of three WNS-susceptible species have been banded to track movement, survivorship, and disease progression (little browns ~ 2600, northern long-eared ~ 400, and tricolored bats ~ 850). Fall swarm capture rates for these species at entrances to known affected hibernacula have fallen 70 percent, 90 percent, and 80 percent respectively since 2009 (see figure). Declines in hibernating little brown bat populations where WNS has been documented for more than one year generally exceeded 90 percent over the same period. Populations of hibernating tricolored bats show a highly variable degree of decline, with highest declines observed in caves with large little brown bat populations. Hibernation counts (Jan–Feb, 2011) of Indiana bats in several WNS-positive caves were consistent with pre-WNS level, and fungus has only been observed on Indiana bats in a single Virginia cave. Indiana bats have also appeared in a handful of Virginia caves where they had not previously been documented, and in higher than normal numbers in some caves from which they've traditionally been known. Finally, bat biologists in Virginia have banded over 1,600 gray bats, a species that is closely related to many WNS-susceptible species. Presence of *Geomyces destructans* on gray bats was first documented in 2010 in Missouri, but associated pathology has yet to be observed.

Dr. David S. Blehert Talks About White-Nose Syndrome

By Meredith Hall Weberg (from notes), Virginia Cave Board

The U.S. Geological Survey (USGS) hosted one of its own employees, Dr. David S. Blehert, a microbiologist at the USGS National Wildlife Health Center in Madison, Wisconsin, to present a program on white-nose syndrome (WNS) on March 7, 2012. A number of cavers attended, including Ellie Florence, Bob Hoke, Cheryl Jones, Barbara Moss, Gary Moss, John Pearson, Susan Posey, Steve Stokowsky, Chris Swezey, Susi Weston, and me. Although very informative and detailed, the lecture was geared towards an audience of non-cavers and non-scientists.

Dr. Blehert began by introducing bats, which are the only mammals capable of "self-powered flight." Although nocturnal and producing only one young a year, bats are the second largest group of mammals—there are about 1,100 bat species out of about 5,500 mammals. (Rats are the largest group!)

White-nose syndrome is considered an "emerging fungal disease of bats" and occurs during the periods of "natural immunosuppression" that occur when bats hibernate. Dr. Blehert explained in very simple terms how the fungus causing WNS, *Geomyces destructans* (*G.d.*) affects the health of bats primarily by invading the wing membrane and disrupting important physiology. One of the slides showed the critical functions of a bat's wings, other than flight: heat dissipation, water control, gas exchange, and blood pressure regulation. Dr Blehert explained that, despite its name, WNS's "greatest damage is to wings."

G. destructans has been found in the soil of caves with WNS-infected bat populations and can remain dormant if conditions are not quite right for it to propagate. A cold-loving fungus, it thrives in temperatures between 40–59oF. There is no cure for fungal infections, which I didn't know; you can treat them—think of athlete's foot—but you cannot fully get rid of them. I think this is because of their ability to remain dormant for long periods of time. Dr. Blehert called this a "second life phase" and a bat is a "hibernating jar of fungus food."

WNS is caused by the fungus *Geomyces destructans*, which Dr. Blehert named. It turns out that this fungus also exists in Europe and probably had a "single point introduction to the United States." It was discovered in New York by biologists in the winter of 2006–2007, but had been photographed a year earlier by a caver. By the winter of 2008–2009, WNS had been found in Virginia, about 9,000 kilometers from its epicenter. It has spread continually each year, although more slowly, and though the maps show Oklahoma and Missouri as possibly having WNS, DNA tests prove it is "not yet confirmed" in those states. There are fewer caves infected west of the Appalachian Mountains than along this line of East Coast mountains.

Six species of bats have been hard hit: little brown, big brown, northern long-eared, eastern small-footed, tricolored (formerly known as Pipistrelles), and Indiana, which is an endangered species.

By 2008, Dr. Blehert's lab in Wisconsin was involved "in earnest" with WNS research. Dr. Melissa Behr, formerly of the New York Department of Health and now with the Wisconsin USGS lab, collected samples of the fungus from bats in caves; the "hooked spores" of *G.d.* seen in her photographs were the first time this shape had been found in a fungus and clearly differentiated it from the many other, common Geomyces species. Scientists have learned that *G.d.* has an upper temperature limit of about 66 degrees; it requires cold dampness for growth. "*Geomyces destructans*" basically means "destroying soil fungus" in Latin.

Dr. Blehert discussed Koch's Postulates and the importance of that process to determining that *G.d.* was indeed the cause of WNS:

1. *G.d.* must be found in abundance in all organisms suffering from the disease but should not be found in healthy organisms.
2. The fungus must be isolated from a diseased organism and grown in pure culture.
3. The cultured fungus should cause disease when introduced into a healthy organism.
4. The microorganism must be re-isolated from the inoculated, diseased experimental host and identified as being identical to the original, specific causative agent.

These tests proved *Geomyces destructans* causes WNS.

Other research confirmed transmission of *G.d* from bat to bat. This same study would seem to prove that transmission by air was not possible, though Dr. Blehert believes that this might have been due to forced air circulation around the bat cages and that further research is necessary.

By the nature of fungi, including being hearty and resilient, the possibility exists that humans may carry *G.d.* from cave to cave via clothes or boots. This concern was the impetus behind the widespread moratorium on recreational caving a couple of years ago and the development of decontamination procedures for clothes and gear used in caves.

Dr. Blehert talked about the study that was based on 550 samples of soils taken from 120 caves by both biologists and cavers. The study was "able to culture viral fungus from the soil" and observe their DNA. Scientists then replicated the fungus based on the DNA, infected some healthy bats with it, collected fungus from the bats, and determined that this was the same *G.d.* Out of 24 soil samples, 11 different species of Geomyces were identified.

By looking back at past records and photos, scientists learned that WNS had been observed in Germany in the early 1980s and has now been identified in 12 European countries. Scientists can only theorize why European bats seem unaffected by *G.d.*, and why the bats are not dying there as they are in eastern North America. Bat populations are smaller and more disbursed in Europe than in this continent. Perhaps WNS killed large populations generations ago and those that remain have a genetic resistance. European bats are larger than those in North America—perhaps this has provided protection. Our smallest bats have the highest mortality rates.

However there is hope for bat survival. Another study woke up sick bats and provided food, water, and warmth. These bats made a full recovery, one reason being that bats can grow new wing skin, thus repairing the damage.

Bats are not considered migratory mammals, but do move up to 200 miles between summer and fall homes. As we know, they are predators of insects "that cause vector-borne disease and impact crop and forest health." Mortality from WNS in some areas "has been documented up to 100 percent." The average decline is 80 percent.

Dr. Blehert said that decontamination of clothing and articles used in caves is "something that should be encouraged." We met him after the talk and told him we decon as best we can and he agreed it is difficult even for researchers to decon in the field.

Author's note: Thanks to Cheryl Jones for fact checking and heavy editing!

Some WNS Links:

USGS National Wildlife Health Center in Madison, Wisconsin:
http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/

U.S. Fish and Wildlife White-nose Syndrome page:
http://whitenosesyndrome.org

National Speleological Society White-nose Syndrome page:
http://caves.org/WNS/index.htm

Virginia Cave Board Main Web page with links to WNS policy:
http://www.dcr.virginia.gov/natural_heritage/cavehome.shtml

Geomyces destructans and Fungal Diseases:
Presented by Dr David Blehert
WNS Webinar Series
http://tinyurl.com/7qgjqr9

Coming Soon: Karst Trail Website!

by Babs Bodin, Virginia Cave Board

The Virginia Cave and Karst Trail (VCKT) will go online in the near future! A project undertaken by the Virginia Cave Board, the VCKT was mandated by the Virginia Outdoors Plan. In lieu of printing costly paper brochures that would require constant revision when additional trail segments were built, the Board instead decided to use the more green alternative of furnishing karst enthusiasts with easily downloadable driving and hiking directions to the Commonwealth's karst features. The Board is currently searching for a URL address before designing the website.

A crucial component of website design entails developing a distinctive VCKT logo. To this end, the Education and Outreach Committee has asked several artists to submit easily recognizable drawings incorporating stylized graphic depictions of karst elements, such as mountains, streams, caves, sinkholes, and hikers, within a Virginia map outline. Once finalized, the logo will serve as a marketing brand, not only on the website, but also on all Virginia Cave and Karst Trail signage and even letterhead.

At present, the VCKT has several trail segments either finished or in the process of completion. The walking trail at Hupp's Hill (Strasburg), which contains permanent interpretive signage, is being maintained, while a trail segment at the Germanic Heritage Foundation (Tom's Brook) is being studied. The Museum of the Shenandoah Valley (Winchester) is incorporating karst elements into its Wood Walk, which is being designed to include several gardens that will take visitors on a visual timeline from the early 1600s through 1900.

The trail segment at Skyline Caverns is essentially finished, requiring only a little more interpretive signage. It includes a kiosk built by Eric and Earle Berge that provides an interpretive map of the karst features found on the walking trail. Residents of Nokesville, the father and son duo worked closely with the Front Royal Grotto to lay out the walking trail's path, then son Earle completed his Eagle Scout project on the site. Earle, from all accounts an extraordinary young man, showed exemplary leadership skills in soliciting donated building materials from a local supply store and then directing and supervising the scouts and grotto members who actually constructed the trail. When asked why Earle had wanted to undertake the karst trail as his Eagle Scout project, Eric replied that his son wanted to do something educational that would benefit the entire community. Obviously, as part of a statewide program to educate our citizens about karst resources, Earle's efforts will reach a much wider audience than maybe even he envisioned.

An exciting project that is making excellent progress is the almost-35-mile driving trail dubbed the Cowpasture River Karst Trail (western Highland County). Trail designer Rick Lambert has identified nine stops along the scenic route and is working with geologists to develop the interpretive text for the signage that will be erected at each stop. Karst features at these stops include springs and sinkholes at the base of Sittlington Hill and in the Bullpasture River Gorge, as well as Marcellus shale and a sinking stream along the Cowpasture River Road. To better view these karst features, Rick is working with the Virginia Department of Transportation to establish pull-offs and parking areas.

Certainly, the Virginia Cave and Karst Trail website will prove invaluable in getting visitors to these and later other rich karst resources.

How Karst Shaped the Civil War in Virginia

By Judy Molnar, Virginia Cave Board

Last year Virginians commemorated the 150th anniversary of the beginning of the Civil War, but how many residents realize how much the geology of the state's Valley and Ridge province contributed to shape the events of that conflict?

Let's begin with the province's geology. Valley and Ridge rocks are mainly limestone, sandstone, dolomite, and shale. Limestone soils are neutral in pH and rich in minerals, highly productive for pasture, wheat, corn, fruits, and other crops. Given these reasonably fertile soils, a humid climate, and a long growing season, the Shenandoah Valley became the "breadbasket of the Confederacy."

This same climate, vegetation, and geology also allowed Virginia to become the major mineral-producing Confederate state during the Civil War. The Old Dominion manufactured 40 percent of the South's iron to October 1864. The mines at Austinville in Wythe County provided virtually all of the lead produced in the South, while Saltville ultimately provided two-thirds of the total southern supply of salt. During the war, more than 88 Virginia caves and other niter sources produced over half a million pounds of saltpeter for gunpowder, more than any other Confederate state.

Any elevation was strategic. High ground affords the army that holds it an almost clear view of troop movements or a clear field of fire against opposing troops down slope. Generals Jackson in 1862 and Sheridan in 1864 both used Hupp's Hill as campsite, observation post, staging area, and battlefield. Signal Knob, on the north tip of Massanutten mountain, offered views of three Valley counties. Signal flags at the Knob sent Confederate dispatches from Strasburg to successive stations down the mountain to the New Market telegraph station and messages reached Richmond within an hour.

Caves and other low spots were also militarily useful. Caves were easy to defend and hard to capture, so they served as temporary holding cells for prisoners, field hospitals, refuges by stragglers hiding from enemy patrols, and shelters for deserters from both sides. Caverns also afforded some recreation and respite from the heat. The signatures of hundreds of soldiers (from both sides) camped in and near caverns are preserved on the walls and formations of several of Virginia's tourist and wild caves.

Sinkholes were used as munitions dumps or lifesaving shelter during battles. Union Colonel Rutherford B. Hayes related an incident during the Battle of New River Bridge: "There was a large lime stone sink hole, in which I ordered the men to lie down. All obeyed promptly except one dismounted cavalryman who in a pert and saucy way turned to me and said, 'Why don't you get off your horse and hide too?' On my repeating the order, the cavalryman replied, 'I'll get down when you do.' Just as I was insisting on his obeying the order a shell burst near us—the cavalryman was fatally and shockingly wounded and was then discovered to be a woman. She died almost instantly."

The province's general topography gave a tactical advantage to the South during the Civil War. Glance at a satellite map of the Shenandoah Valley and you'll notice that its ridges and valleys trend northeast to southwest. This orientation allowed any Confederate army moving north in the Valley to draw closer to Washington D.C., while a Union army moving south would draw away from Richmond. If Union armies were to attack the region from the west or the east, they were forced to move through treacherous steep ridges, narrow valleys, numerous streams, and poor roads. This geology made it virtually impossible to supply a sizeable army, and snow or torrential rains didn't make transport of men, heavy artillery, and supplies any easier. Relatively small Confederate forces could cut supply lines at will and starve a large army into submission. Narrow gaps through the mountains could become dangerous death traps. Since the Valley Pike, which ran through the center of the Shenandoah Valley, was the one all-weather road for travel, both armies depended on it for transport.

The narrow valleys formed by 50-mile-long Massanutten Mountain and the two forks of the Shenandoah River channeled troop movements and influenced military strategy. In 1862 two separate sets of Union troops moved south on either side of Massanutten attempting to crush the Confederates in a trap. General "Stonewall" Jackson's men raced to the southern tip of the mountain and successfully fought back-to-back battles at Cross Keys and Port Republic to prevent the Federal troops from uniting. Jackson also used Massanutten to screen his movements northward so he could attack a small Union garrison at Front Royal. General Lee's Army of Northern Virginia used the Valley for supplies and as a primary highway that screened his troops moving north to Gettysburg. But the Union also learned to use the Valley's geology to their advantage. General George Crook used Hupp's Hill to hide his army's advance to the foot of Little North Mountain in the fall of 1864. The next day Crook's men surprised General Jubal Early's Confederate troops at the Battle of Fisher's Hill, then proceeded to burn their way through the Valley. Once Union General Sheridan won the battle of Cedar Creek in 1864, he ended Confederate control over the Valley. Once the Valley was lost, the war was lost.

The Ridge and Valley karst landscape provisioned the South with food and strategic minerals. Its topography served as the backdrop to the War's battles and was vital to military strategy and the movements of goods, refugees, and troops throughout the Civil War.

References:

The Great Valley Road of Virginia: Shenandoah Landscapes from Prehistory to the Present. 2010. Warren R. Hofstra and Karl Riaitz, eds. U of Va Press

The Hupp's Hill Civil War/Karst Interpretive Walking Trail signage, courtesy of Babs Bodin

Tourist pamphlets about the Shenandoah Valley's 1862 & 1864 Civil War Campaigns.

Several articles from *Underground in the Appalachians: A Guidebook for the 1995 NSS Convention*, edited by Carol Zokaites, National Speleological Society, Huntsville, Alabama.

Saltpetre Caves and Virginia History, a pamphlet published by Burton Faust as a 1964 reprint from *Caves of Virginia* by Henry H. Douglas, p 47, 50.

"Geology And History Of Confederate Saltpeter Cave Operations In Western Virginia" by Robert C. Whisonant, 2001 Virginia Minerals Vol 47 #4 November https://www.dmme.virginia.gov/DMR3/dmrpdfs/vamin/VAMIN_VOL47_NO04.pdf

Civil War Mineral Series by Robert C. Wisonant:
Lead: https://www.dmme.virginia.gov/DMR3/dmrpdfs/vamin/VAMIN_VOL42_NO02.pdf
Salt: https://www.dmme.virginia.gov/DMR3/dmrpdfs/vamin/VAMIN_VOL42_NO03.pdf
New River Bridge battle: https://www.dmme.virginia.gov/DMR3/dmrpdfs/vamin/VAMIN_VOL43_NO04.pdf
Iron: https://www.dmme.virginia.gov/DMR3/dmrpdfs/vamin/VAMIN_VOL44_NO04.pdf

Virginia Cave Board Policy on Algae Abatement

December 18, 2011

The Virginia Cave Board is concerned with maintaining the natural condition of speleothems within caves to the greatest extent possible and recognizes that this can be a challenge to cave management, especially within caves that have lighting systems installed. Artificial lighting within caves promotes the growth of algae, moss, ferns, and other photosynthetic organisms, collectively called "lampenflora." The Cave Board has looked into the Virginia Region cavers' methods of algae abatement and consider them to be right in line with current best practices.

From a biological point of view, the less cleaning of speleothems the better. However, removing existing lampenflora is a desirable goal of good cave management. To this end, the Virginia Cave Board makes the following recommendations:

- Do not use bleach to clean formations. While a 5 percent bleach solution kills lampenflora, it is not recommended because it releases toxic chlorine gas and possibly carcinogenic chlorinated compounds, and it may kill the native cave biota.
- The current best practice is to use a spray bottle to apply a 15 percent solution of hydrogen peroxide to affected formations. This is much more environmentally friendly. If feasible, the washing solution and resulting detritus should be contained and removed. The main drawback to the use of hydrogen peroxide is that it is acidic (pH 4) and may be slightly corrosive to formations and limestone.
- Mechanical removal should be minimized, but if necessary, it should be done cautiously with soft, nylon-bristle brushes. Mechanical removal with water and brushes is not sustainable because fragile formations may be destroyed.
- Rinsing with cooled, boiled tap water is also recommended. If your water supply has chlorine added, you may let your "rinse water" sit out for several hours. This has the same effect as boiling in that it allows the release of any chlorine.

VAR cavers use hydrogen peroxide in a 15 percent solution sprayed on speleothems. They let it sit for 20 to 30 minutes, then rinse with water. If need be, they then use nylon-bristle brushes to gently clean off any remaining algae. They clean up whatever runoff occurs from this process. This is done after they determine that cleaning with water only will not be sufficient. On areas where decades of gravel dust has built up, they use water and nylon-bristle brushes to gently clean the formations.

The Cave Board hopes that you will seriously consider our recommendations. We would be pleased to discuss this matter with you further.

Department of Conservation and Recreation, Division of Natural Heritage
217 Governor Street, 3rd Floor
Richmond VA 23219-2010
RETURN SERVICE REQUESTED

For additional information please contact the Virginia Department of Conservation and Recreation, Division of Natural Heritage, 217 Governor Street,3rd Floor, Richmond, VA 23219 or one of the members of the Virginia Cave Board.

Ms. Barbara Bodin
218 Tudor Drive
Winchester, VA 22603

Dr. David Culver
427 Foxridge Drive
Leesburg, VA 20175

Dr. Daniel H. Doctor
U.S. Geological Survey
12201 Sunrise Valley Drive
Reston, VA 20192

Mr. Andrew Harrison, PG
3513 Grandview Drive
Richmond, VA 23225

Dr. John R. Holsinger
Dept. of Biological Sciences
Old Dominion University
Norfolk, VA 23529

Mr. Thomas Lera
7733 Inversham Drive, No. 167
Falls Church, VA 22042

Mr. Steve Lindeman
The Nature Conservancy
Holly Knob
6630 Hayters Gap Road
Saltville, VA 24370

Ms. Judy Molnar
Virginia Living Museum
524 J. Clyde Morris Boulevard
Newport News, VA 23601

Mr. David R. Socky
6572 Woodbrook Drive SW
Roanoke, VA 24018-5402

Ms. Meredith Weberg
8061 Kittiwake Court
Springfield, VA 22153