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HARLANSBURG CAVE:
THE LONGEST CAVE IN PENNSYLVANIA

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Harlansburg Cave is a network maze developed in the Vanport Limestone. The cave covers an area of approximately 200 meters by 200 meters, and 6647 meters of passage have been mapped. Typical passages are mud and water floored. Three pools in the southern portion of the cave were studied for their geological and biological characteristics. Geological studies indicate the cave to be a reservoir for water seepage from the overlying fields. The water is highly aggressive as a result of the overlying Kittaning Sandstone. Biological analysis indicate that the bacteria/actinomycete populations are the result of infiltration from the overlying fields. The exception is Hafnia sp. *which apparently arises from the raccoon population which frequents areas of the cave.*

The cave was discovered in October of 1950 as crews started to open a road cut west of the village of Harlansburg, PA (News, 1950a; Smith, 1970). As the blasting holes were drilled, numerous large voids were encountered 5-10 m below the surface. When the blasting charges were detonated, seven entrances were revealed. The local newspapers reported that the roadway appeared to have cut through the center of a cave system.

Newspapers published numerous features on this newly discovered natural wonder (News, 1950b; News, 1950c). The cave was reported to contain underground lakes, millions of bats, huge speleothems, vaulted rooms, bottomless pits and mud. The mud covering the floor of the cave was said to be a few centimeters to over a meter in depth. In several areas the mud was noted to be overlaid with up to one meter of water (News, 1952).

Soon after the cave was opened, hundreds of explorers attempted to enter the mysterious maze. Carl Leathers, a local resident and competent cave explorer, often discussed the poor state of preparedness of the amateur speleologists (Moody, 1966). Unfortunately, the reckless manner of early visitors led to vandalism, littering, and near tragedy.

On October 23, 1950, three explorers (12, 17, and 30 years of age) entered the cave. The trio became disoriented and as their flashlights dimmed they decided to wait for help. When their plight became apparent, a massive rescue ensued. Pennsylvania Power provided “a mile of wire to light the passages if the need arose.” A bloodhound was sent for by the local sheriff. Hundreds of well-meaning volunteers assisted in looking for the lost trio. After eleven hours the three explorers were found “1500 feet underground” and “2000 feet from the entrance” (News, 1950a).

On October 25, 1950, a group of scientists from Carnegie Museum entered the cave. Prominent in the group was John Guilday. They explored about “3600 feet into the maze” and placed Harlansburg as the “most outstanding [cave] in this part of the country” (News, 1950b). A second group of scientists from Kent State University entered the cave on October 30, 1950. Led by Dr. Elizabeth Smith, the group captured and banded several bats (News, 1950c). Attempts to locate records of these early studies have been unsuccessful.

The cave was officially closed the next weekend by Sheriff Coen despite requests from several groups to keep it open. He spoke of the dangers lying in wait for any explorer. Trips apparently continued to the cave over the next several years (News, 1952; Moody, 1966).

One local entrepreneur, Challice Bruce of New Castle, felt the cave was worthy of commercialization. He stated that if the mud could be removed, the cave had great potential. He started to map and photograph the cave. In May of 1952 he reported that the cave extended from Leesburg in the north to Rose Point in the south with the exposed Harlansburg’s entrances in the center of the maze (News, 1952). This description would mean the cave covered a distance of over eleven miles. Many residents still remember and believe these reports.

Challice Bruce is also remembered as “the founding father of the Mid-Appalachian Region of The National Speleological Society (White, 1990). After Mr. Bruce’s death, his widow gave his records, photographs, book collection, and memorabilia to a local high school. Unfortunately, these records were discarded by officials as space was needed for other materials.

The cave remained accessible and was frequently visited until 1966. Three inexperienced explorers precipitated a rescue that brought news media, onlookers, volunteers, and much unneeded anger from local officials (News, 1966a; Moody, 1966). Seven days after the rescue, the local highway superintendent, with reporters witnessing the event, poured concrete into the entrances. The cave was now officially closed.

In 1977, the authors began a systematic study of the cave. The cave is again open and traffic into the cave is moderate.

MAPPING

First trips into the cave revealed an intricate, mud-floored maze. The floors of the passages are typically soft mud (10-75 cm deep) covered with a layer of water (3-100 cm deep). Breakdown predominates in many sections of the cave.

The cave consists of essentially two portions separated by the road cut. Survey efforts concentrated on the apparently larger, southern section (Figure 1). The northern section has some highly unstable areas as a result of repeated attempts to seal these entrances by blasting.

Initial mapping trips were hindered by the complexity of the maze coupled with some erratic compass readings as a result of the magnetic properties of the overlying Buhrstone Iron deposit (White, 1976b). Although this layer is only a few centimeters thick, it complicated compass readings when survey teams inadvertently established mapping stations on pieces of magnetized former ceiling. The data were collected in the field using standard compass and tape techniques (Hosley, 1971). Multiple azimuths were taken from each station; any variation between forward and reverse measures necessitated resampling of that segment. Data were analyzed after each trip using a computer program designed by the authors.

The cave is a network maze with the larger passages running north to south from the entrance. These passages are up to four meters high in the eastern portion of the cave (average height of approximately two meters) and gradually diminish in height as you move towards the west. In is not uncommon to find high passages in certain portions of the western region of the cave. The east/west interconnecting passages are typically lower than the major north/south passages.

The first major accomplishment came with the completion of a survey of the cave's periphery. One hundred eighty stations were measured with a closure error of 1 meter for every 387 meters surveyed. The average sighting distance was 5.8 m. Ceiling heights ranged from 0.5 to 3.4 m with an average of 1.8 m. This loop established the approximate dimensions of the cave and allowed the authors to divide the remaining cave into workable sections. The mapping phase took seven years to complete. Over one hundred Westminster College students participated in the project. The Westminster Student Grotto, with the authors' guidance, made over 120 survey trips into the cave. This translates into 4800 hours expended in mapping "our" cave.

The cave has 6647 m (21808 ft) of passage contained in a area 200 m by 200 m. The general trend of the major passages is a 160 degree azimuth. The breakdown that litters the floor of the cave may be partially a result of the draining of the cave and the subsequent drying after opening (White, 1976b).

To the east of the entrance room are two prominent areas with an abundance of actinomycetes. The rooms have been labeled by early explorers as the "Glow Rooms" due to the reflectance of water condensed on these microbes. Although found in many areas of the cave, these two rooms have the largest population of these organisms.

Also, on the eastern side of the cave is Coon Heaven. This region is located about 100 m southeast of the entrance. The passages are 3-4 m in height and 2-3 m wide with the Kittaning Sandstone apparent in the ceiling. The floor is firm mud with a relatively smooth surface resulting from periodic flooding and draining of this region. As the name indicates, numerous raccoon tracks can be seen in the mud. The entrances for these animals from the outside are abundant but too small to allow human passage.

To the southwest 55 m, one encounters the Smoking Room region. The area was named by some earlier unknown explorer who wrote with a carbide flame on the wall. The passages are 2.5 m high and 2 m wide with a solid limestone ceiling. The floor is again firm mud. This area served as a base station during our mapping and, if located, can serve as a convenient way to easily find other regions of the cave.

To the west another 45 m is Carls Table. This room is characterized by a large flat piece of ceiling breakdown that sits prominently in the center of the room. The passages leading north from Carls Table enter the cave's largest room. This room's width is about five meters with a ceiling capped with Kittaning Sandstone. The ceiling height is approximately 5.5 m but the height is masked by the large quantity of breakdown on the floor. What has developed is a 5.5 m high room with a 3.5 m mountain of breakdown in the center.

The Ruby Room and Crystal Lake are another 60 m to the west. The Ruby room is named for its ferruginous dripstone and flowstone deposits (Long, 1981). The presence of the iron in these speleothems was verified by dissolving a small broken piece of speleothem breakdown in hydrochloric acid and performing a standard test for the iron ion. The bright red-orange speleothems are the most colorful in the cave. Next to the Ruby Room is a small passage (0.4 m high) that leads to a room with several undisturbed soda straws, stalactites, and stalagmites. These two areas contain most of the remaining speleothems in the cave. There is evidence that larger speleothems existed in the northwest section of the cave but only fragments survive the early collectors' removal of souvenirs.

Crystal Lake is a series of water-filled (0.5-1.2 m deep) passages which have an abundance of excellent crinoid stems in the walls and ceilings. North of Crystal Lake 75 m is the Hub Room complex. As the name suggests, several high passages radiate from this area. Ceiling height is about 2.5 m with several large *Lepidodendron* leaf fossils in evidence.

Just 20 m north of this region is the Catacombs. The name again results from an unknown caver's carbide lamp. The passages are 1.0-1.5 m high with an average width of 1.0 m. The floor consists of firm mud and the network pattern forms a small regular maze. Evidence exists in this area of significant speleothems. Unfortunately, all that remains are fragments too large for early explorers to have removed easily from the cave.

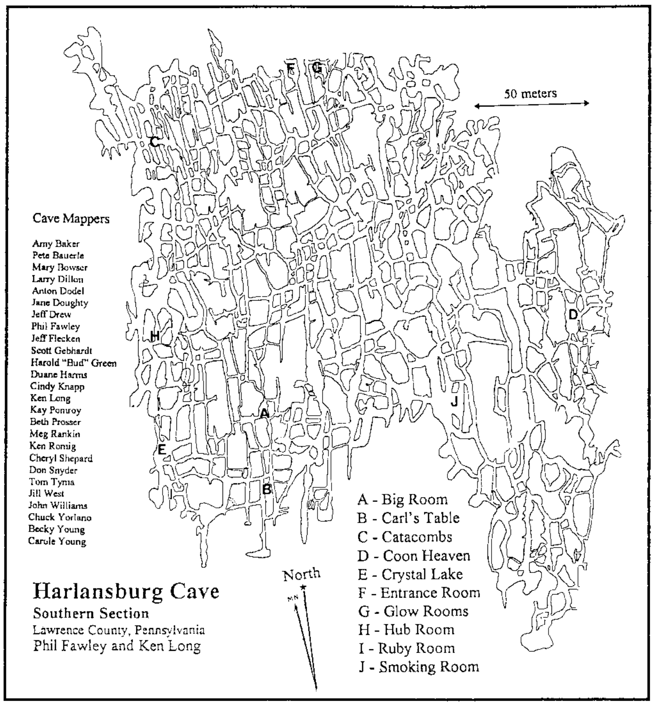

Figure 1. Map of Harlansburg Cave, Southern Section, Lawrence County, Pennsylvania.

GEOLOGY AND HYDROLOGY

Harlansburg Cave is formed in the Vanport Limestone (White, 1976). This is a dense gray formation in the Allegheny Group of the Pennsylvanian System (Poth, 1963). The Vanport Limestone has a low magnesium carbonate content, averaging 1.4% for a total of 18 samples in the Lawrence and Butler Counties (O'Neill, 1976). Silica averaged 2.8% and calcium carbonate 93.6%. Trivalent metal oxides averaged 2.2% in the 16 samples for which analyses were reported. Crinoid and brachiopod fossils are common.

Just east of the cave, where the village of Harlansburg is located, a stream channel has been cut through the Vanport Limestone and the underlying Clarion, Homewood and Mercer Formations. The bedrock in the stream is the upper Connoquenessing Sandstone (Poth, 1963).

In some locations in the cave, 10 to 20 cm of the Buhrstone iron ore, a limonitic iron ore (Poth, 1963), lie atop the Vanport Limestone while the iron ore appears to be missing in other places in the cave. Overlying the iron ore in this area is the Lower Kittanning Formation, a channel sandstone. The total thickness of the Kittanning and the overlying unconsolidated deposits ranges from 7.5 to 15 m in this locality. There are places in the cave where blocks of limestone breakdown have thin (two to five cm) Kittanning beds "draped" over them.

Where passages are wide (two to three meters), there is danger of breakdown of the Kittanning Sandstone. One member of a mapping team was narrowly missed by a block of rock weighing perhaps 40 to 50 kg. In a number of places, compression fossils and casts of plant stems are visible in the Kittanning ceiling and in blocks of breakdown. On the other hand, narrow passages tend to taper to a narrow fissure at the top and appear to be quite stable.

In the area where the cave is located, the thickness of the Vanport Limestone varies between 4.5 and 5.5 m (Poth, 1963). This and the experiences of the mapping teams contradict reports of a 90-foot (30 m) pit (Smith, 1970).

Maze development is typical of caves in the Vanport Limestone. Other examples are Brady's Bend Cave, Hineman Cave, Sarah Furnace (Porter's) Cave, Portersville Cave and Rose Point Cave (White, 1976). This common pattern of development has been attributed to seasonal fluctuations in the level of the streams draining the area. At high flow levels, water would be forced into the joint system and later drained when the stream level fell during late summer. This mechanism prevents the development of one trunk passage with few parallel passages. "The lack of high velocities and the moderated flow permits all joints to open uniformly thus developing the closely packed network of passages" (White, 1976). Here the main cave passages are approximately parallel to the stream channel at Harlansburg.

Although Harlansburg Cave is very wet, no large water inlets have been found. At times of heavy rainfall or snowmelt there is rapid dripping at many points in the cave. At such times the water level rises quite quickly and then falls more slowly. While the water level is high, water may be seen flowing within the cave. The observed flow has been to the west and north in the western half of the cave. In the east central part of the cave, no water movement has been observed while farther east there are gravel floors in some passages. This indicates that at some times flowing water must have removed the clay and mud that form the floor in other parts of the cave. About 63 m west of the entrance, water that has moved north and west reaches a drain where it flows underneath the side wall of a passage.

HYDROLOGY STUDY

To further characterize the cave, two pools were selected for study of their water chemistry and microbial content (Long & Fawley, 1981). Carls Table Pool is located next to a large flat-topped block of limestone breakdown located 115 m south of the entrance (Figure 1). An overhanging ledge protects the adjacent pool from casual intrusion by cavers. When near its low level it has an area of about 7 to 8 m^2 and has a reverse "J" shape. The average temperature of this pool is 9.8 ± 0.1ºC.

Crystal Lake, about 130 m south-southwest of the entrance, is much larger with a surface area of about 175 m^2, extending through approximately 128 m of passages. Occasionally the water is stirred up by cavers who walk through its cold (average temperature 9.4 ± 0.1ºC) waters that are up to 1.0 m deep. The walls of the passages are nearly vertical so that the area occupied by the lake does not change very much when the water level changes.

In each pool an arbitrary reference point was established so that water levels could be measured without entering the water. All levels in Figure 2 are based on the reference point in Carls Table Pool. On sampling trips, the pH of the pool waters was determined (Long & Fawley, 1981). The pH of a sample of water which was removed and saturated with excess recrystallized calcium carbonate was also determined (Picknett, 1964). In addition, pairs of water samples were collected from each pool. One sample in each pair was saturated with excess calcium carbonate. Each pair was then analyzed for total calcium (as $CaCO_3$) by EDTA titration. (For tables of data, see Long & Fawley, 1981.)

Since the water levels in the pools varied during the study period, the question arose as to how these water levels were related to ground water levels. Ground water data from USGS well number 1201 (latitude 41º05’38”N, longitude 80º28’08”W), the USGS well nearest the cave, were obtained from the Pennsylvania Geologic Survey as a computer printout. The data are expressed as depth below the land surface to the surface of the water in the well. The water level showed large fluctuations during the period from February 1979 to September 1979 with a range of 150 cm. The level tended to fall during the study period (Figure 2).

The water levels of both pools varied but also tended to decrease during this time span. However each cave pool varied over a much smaller range than the water table as measured in the USGS well during this time, a range of 28.4 cm for Carls Table Pool and a range of 14.8 cm for Crystal Lake. Since the pool levels were measured from a reference point below the surface of the pool, a low level was indicated by a smaller measurement. On the contrary, a low water level in the well was indicated by a larger measurement. Thus, the data show a negative correlation coefficient, -0.8740 for Carls Table Pool (Long & Fawley, 1981).

Water levels in the cave increase rapidly during the spring thaw or if there is continued heavy rainfall. When water levels fall, they do so more slowly. Evaporation in this environment is minimal. Clearly in the case of Carls Table Pool the major way in which water can leave is by slowly seeping through the clay that forms the sides and bottom of the pool. Probably the same is true of the much larger Crystal Lake except during very high water levels when flow to the north has been observed.

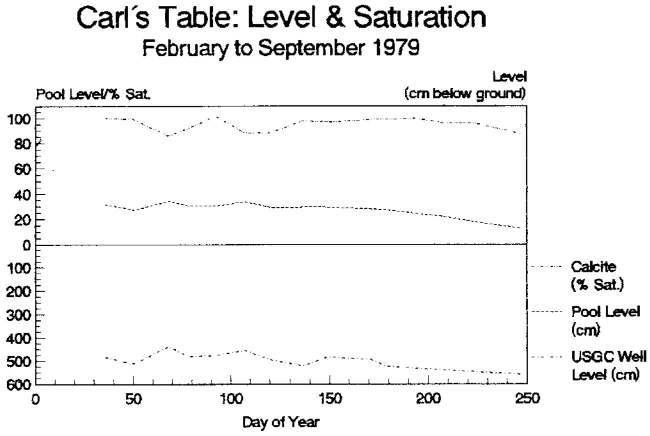

Figure 2. Carls Table Pool Level and Percent Saturation as Compared with USGS Reference Well.

From the titration data, the ratio of the concentration of calcium carbonate in the pool waters to the concentration of the paired saturated sample was determined and expressed as a percent. A graph of these data is shown as Figure 2. (Again, Crystal Lake data are very similar so only one graph is presented.) When the water levels rose sharply, the concentration of $CaCO_3$ fell as would be expected if the added water diluted the water in the pools. This water was much more aggressive as indicated by larger amounts of calcium carbonate required to saturate the paired samples. Since very little limestone lies over the cave in these pool areas, little additional calcium carbonate can be dissolved by the entering water.

As the water level falls, the concentration of $CaCO_3$ increased, but the water actually became a bit more aggressive as indicated by somewhat larger increases in the amount of $CaCO_3$ required to saturate the water. Thus, the percent saturation fell slightly. The higher concentrations of $CaCO_3$ in the water can be explained if there is some dissolution of the limestone that is in contact with the pool water. These changes cannot be due to loss of CO_2 from the pool water.

MICROBIOLOGY STUDY

Despite a paucity of nutrients and other biotic factors in caves of this region, a wide variety of organisms have been described in cave environments throughout the world. In Harlansburg Cave, the authors have encountered larger troglophilic/trogloxenic animal life such as salamanders, bats, meadow voles, earthworms, and raccoons.

The basal trophic levels of this cave’s environment were investigated for this project. Specifically studied were the microbe populations of three pools within the cave. These pools were determined appropriate for study by the work of Hale (1980). Samples were taken from the Carls Table pool and Crystal Lake. In addition, water was collected from a pool near Coon Heaven.

All samples were collected in sterile sampling bottles as soon as the area was approached so as to allow for minimal contamination of the area. Care was taken not to agitate the pool or touch the water with clothing or body. The water was removed from the cave, kept cool during transit, and sampled for analysis within four hours after collection.

One milliliter aliquots were removed, serial dilutions made, and transferred to a series of agar plates. Nutrient agar (Difco Laboratories) was used for bacterial culture. (Buchanan, 1974) Actinomycetes were grown on a starch casein agar (Difco Laboratories) with 20 units/mg penicillin and 40 micrograms/ml streptomycin (Johnson, 1972). Bristol’s agar (Difco Laboratories) was used for the isolation of algae (Starr, 1950). All plates were incubated at 37ºC with the algal plates placed under fluorescent lighting.

Preliminary counts indicated that the Coon Heaven samples had the highest bacterial counts on any sampling day. The raw data indicated a range of 890-4100 cells per ml of water. The actinomycete counts typically varied from 1-160 cells/ml of water. No algae were detected in any Coon Heaven sample.

Crystal Lake samples yielded lower counts for bacteria (820-2400 cells per milliliter) and actinomycete (1-140 cells per milliliter). Algae were not detected in any sample.

Carls Table had the lowest counts of the three areas studied. Bacterial counts ranged from 35-1050 cells per milliliter. Actinomycete counts were quite low at 0-12 cells per milliliter. Again, no algae were detected in any sample.

In an attempt to characterize the bacterial samples further, subcultures were made of the plated samples. A total of seven distinct colony types were noted in the samples collected. The individual colonies were then subjected to a series of presumptive and confirmatory tests to determine their identity (Johnson, 1972; Buchanan, 1974). The tests used are listed in Table 1.

Table 1. Tests applied to characterize the individual bacterial colonies collected from Harlansburg Cave. Each trial was run using standard qualitative procedures (Buchanan, 1974; Johnson, 1972).

Bacterial Characterization

Gram Reaction
Morphology

Fermentation Reactions	**Specific Enzyme Systems:**
Glucose	Malonate Utilization
Lactose	Phenylalanine Deaminase
Sucrose	Beta-D-Galactosidase
Salicin	Indole Production
Adonitol	Hydrogen Sulfide Production
Inositol	Lysine Decarboxylase
Sorbitol	Ornithine Decarboxylase
Arabinose	Urease
Maltose	Arginine Dihydrolase
Trehalose	Citrate Utilization
Xylose	

The identities of the seven colonies are given in Table 2. Six of the colonies are typical soil bacteria and could have entered the water by percolating through the overlying strata or carried into the area by various organisms (Caumartin, 1963; Johnson, 1972). The seventh colony was identified as *Hafnia ssp*. This organism is commonly found in feces of mammals. Since the field above the cave has not been used for grazing or farming and few bats were observed in these areas, the authors believe the existence of *Hafnia* was due to the raccoon population in the cave.

Based on the large number of raccoon tracks and the consistent finding of *Hafnia* in the water samples, it appears there is a southeast entrance to the cave system. During the mapping, several small passages were noted at the cave's southeast margin. These are separated by less than 30 meters of limestone from the limestone outcropping east of the cave complex. None of these would allow human passage but a raccoon would experience little difficulty.

The bacterial counts did relate to changes in the water level of Carls Table and Crystal Lake. The counts appeared to rise when moderate to heavy rainfall occurred. We concluded that the source of the bacterial and actinomycete contamination was from water seeping into the cave from the overlying strata and the mammals which frequent the cave (Long, 1981).

The lack of algae in any plated sample would indicate that the flow from the surface to the cave pools was sufficiently slow as to allow for the destruction of any photosynthetic organisms (Johnson, 1972).

Table 2. The identification of the seven bacterial colonies cultured from water samples taken from Harlansburg Cave (Johnson, 1972; Buchanan, 1974).

Microbe Identification
Micrococcus roseus
Streptococcus ssp.
Arthrobacter ssp.
Enterobacter aerogenes
Bacillus subtilus
Pseudomonas ssp.
Hafnia ssp.

CONCLUSIONS

Harlansburg Cave is a network maze with a generalized north/south orientation of the major passages. The evidence available to the authors indicates that the southern part of the cave, described in this paper, is larger than the unmapped northern part. At least part of the northern section could be mapped, although some areas appear to be quite hazardous due to possible breakdown. Geological studies indicate that the cave is currently a reservoir for the water seepage from the overlying fields. The biological data indicated that the bacterial populations in the three pools studied were primarily of seepage origin. The exception was *Hafnia,* which appears to arise from raccoon fecal contamination. Invertebrates and vertebrates have been observed but not systematically collected and identified.

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