AN INTRODUCTION TO CAVES AND CAVE EXPLORING IN GEORGIA

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Introduction

This booklet was written to help answer some questions about caves and cave exploring, or caving as it is more commonly known. (In the author's experience the term "spelunking" is rarely used by cave explorers, who generally call themselves cavers.) This booklet was also written to explain why caves and their contents are unusual or even unique, how they may be easily damaged, and why they should be protected and conserved. In passing the Cave Protection Act of 1977, the Georgia Legislature and the Governor unanimously endorsed the following proposition.

> "The State of Georgia hereby finds that caves are uncommon geologic phenomena, and that the minerals deposited therein may be rare and occur in unique forms of great beauty which are irreplaceable if destroyed. It is also found that the wildlife which evolved to live in caves are unusual and of limited numbers, and many are rare and endangered species, and that caves are a natural conduit for groundwater flow and are highly subject to water pollution, which has far-reaching effects transcending man's property boundaries. It is therefore declared to be the policy of this State and the intent of this Act to protect these unique natural resouces."

Caves are delicate, and so are cavers. Caving, if approached properly and cautiously, is no more dangerous than any other physical, out-door hobby. Most newsworthy caving accidents occur to inexperienced, ill-informed, and improperly equipped novices who usually have violated one or several basic rules of safe caving. Reading this booklet cannot teach anyone to be a cave explorer; caving techniques can only be properly learned directly from experienced cavers.

Finally, if you think this booklet will tell you where to find caves to explore, put it down. Because caves are delicate and unusual natural phenomena, and because most cave accidents happen to poorly prepared beginners, it is the policy of organized cave explorers (members of the National Speleological Society) to restrict information on cave locations. Just as trout fishermen may jealously guard the locations of their secret backwoods fishing holes, cavers guard the locations of their caves. Besides protecting these spots from overuse, litter and vandalism, cave explorers believe they also are protecting inexperienced cavers. By taking beginners on their caving trips and teaching them their techniques and philosophy of caving, they hope to protect our caves for future generations to wonder at and wander in.

Types of Caves

What is a cave? The answers vary, but almost all agree on several points. It is a naturally occurring opening (occasionally without an entrance); it is larger than a person; and it extends into total darkness.

Are all caves formed in the same kind of rock and by the same processes? The answer is yes and no. The vast majority of caves are the same—*solution caves* formed in limestone. Since most of this booklet is devoted to this type of cave, let us first briefly examine some less common, but equally fascinating, types of caves.

The second most common type of cave is the *lava cave* or *lava tube*. Lava tubes are formed when a tongue of molten lava flowing downhill cools off and solidifies on the outside. The interior of the flow, insulated and kept warm by the surrounding lava, remains molten and continues to flow downslope, leaving the solidified outer crust as a hollow shell—a lava tube. Lava tubes are generally simple as viewed from above, although they occasionally branch or merge and frequently have multiple levels. Some lava tubes may be more than 10 miles long. The entrances to lava tubes usually are formed by later erosion and collapse of the roof material, although some of this may occur while the lava is cooling.

There are no lava tubes in Georgia or the southeastern United States, but they are abundant in the northwestern United States, especially in Idaho, Oregon, and Washington. Idaho's Craters of the Moon National Park is particularly well known for lava caves; others are noted in Hawaii, Iceland, and the Canary Islands.

The term *glacier caves* refers to caves formed in ice (fig. 1) in contrast to caves containing ice, *ice caves*. (Another term for ice cave is "glaciere," but since this is easily confused with glacier cave, ice cave is preferable.) Glacier caves usually are formed along the course of streams flowing beneath the ice. The stream passage acts as a conduit for air circulation which promotes melting and sublimation (the direct change of ice to water vapor). These ablation (glacier-wasting) processes keep the cave open and enlarge it. Eddies in the air currents vary the rate of ablation locally, and produce the curious pocketed or fluted character common to the walls of such caves. Perhaps the best-known glacier caves in the United States are the misnamed Paradise Ice Caves formed in the glaciers on the slopes of Mt. Ranier, Wash. More appropriately, these should be called the Paradise Glacier Caves.

Sea caves are another type of cave. They are undercut areas at the base of coastal cliffs where pounding waves and the rock pieces they carry have eroded notches in the rock face. Frequently, they are localized by weaker layers or cracks in the rock which help initiate the erosion. Sea caves are generally shallow, rarely extending into total darkness. The Georgia coast is not marked by cliffs of durable rock which might be undercut, and therefore has not developed any sea caves. In the United States, sea caves are best developed on the Pacific coast of Washington, Oregon, and northern California. Anemone Cave in Acadia National Park, Maine, is also a sea cave.

Figure 1. A glacier cave in Washington showing the typical scalloped walls. Photo courtesy of Dr. William R. Halliday.

Yet another variety of cave may be classed as *tectonic caves*. These are caves formed by the cracking and movement of rock layers, leaving open spaces. Somewhat similar are *boulder* or *talus caves*—openings between boulders piled up at the base of a cliff or slope. Occasionally these winding cracks extend hundreds of feet beneath extensive piles of debris. Minor caves of this type might be found in middle and northern Georgia.

Rock shelters are occasionally known as caves to the local residents. These are undercut areas at the base of cliffs where weaker, less stable layers of rock have been removed by erosion, and massive, durable layers have remained overhead, forming a roof. These areas frequently were shelters for early man and often are archaeological sites. An undercut of this type occurs along the trail which leads down into the canyon at Cloudland Canyon State Park in northwest Georgia. There, crumbly shales have been removed, and a massive sandstone and conglomerate ledge remains to form a roof. This shelter is high enough to stand up in and frequently is a resting point for hikers.

Solution Caves in Limestone

The vast majority of the caves we see or hear about are *solution caves* in limestone. These caves are formed by flowing underground water dissolving the rock material (fig. 2). They are only one feature of what geologists know as *karst* topography, a land surface characterized by bedrock which has been dissolved by chemical weathering rather than worn away by abrasion. Karst surfaces are commonly marked by sinkholes, caves, and an absence of surface streams (fig. 3).

Although karst topography may form on any type of soluble rock, it is most extensively and intensively developed on limestone. Limestone is a sedimentary rock made up of particles deposited in layers at the earth's surface (including under the sea). It may be deposited in several ways, but the particles are always made up of calcium carbonate ($CaCO_3$), usually in the form of piled-up shells and skeletal materials from marine organisms such as oysters, corals, and snails. What is now a thriving coral reef in a tropical ocean will one day be a layer of limestone containing coral fossils.

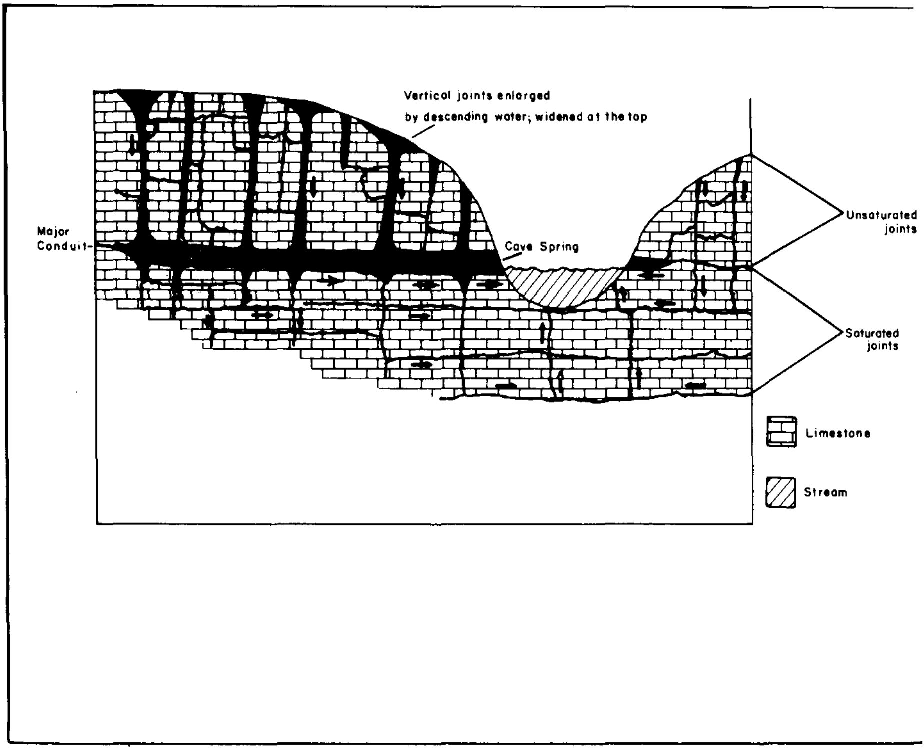

Figure 2. Generalized cross section showing water flow through limestone and the cave-forming process.

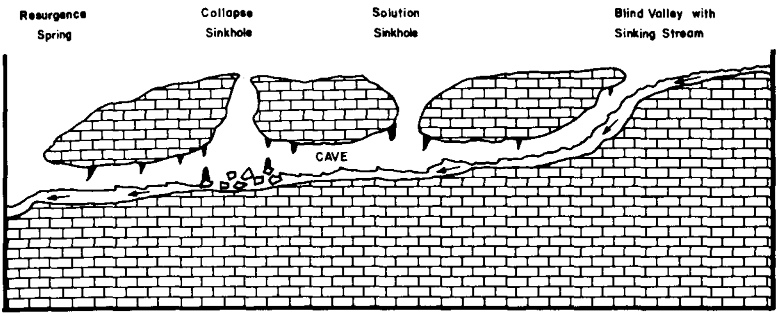

Figure 3. Generalized sketch of some common karst landforms.

In the shallow water behind the coral reef, numerous tropical algae build pea-sized plates of calcium carbonate. Debris broken from reefs by pounding waves is mixed with these plates to form a coarse, cream-colored sand. Layers of this sand later become limestone. Calcium carbonate is also dissolved in seawater, like salt. When the sea water evaporates, layers of calcium carbonate are deposited, just like the crust of minerals deposited in the bottom of a pot of water allowed to boil dry. This process may form layers of limestone on tidal flats or beaches subject to daily wetting and drying.

These processes of limestone formation are working today in clear tropical waters. Both southern Florida and southern California have excellent coastal environments for depositing limestone. However, these same processes also operated in the past. Thousands and millions of years ago, tropical seas existed in areas where today there are high mountains. True, the shells preserved in these limestones were different from those we find now, but the processes of limestone formation were the same. Limestone is found in several areas of Georgia (fig. 4).

The solution of limestone is actually a reaction involving the gas, carbon dioxide (CO_2). Limestone is only sparingly soluble in pure water. However, as carbon dioxide is added to water, a weak acid, carbonic acid, forms. This

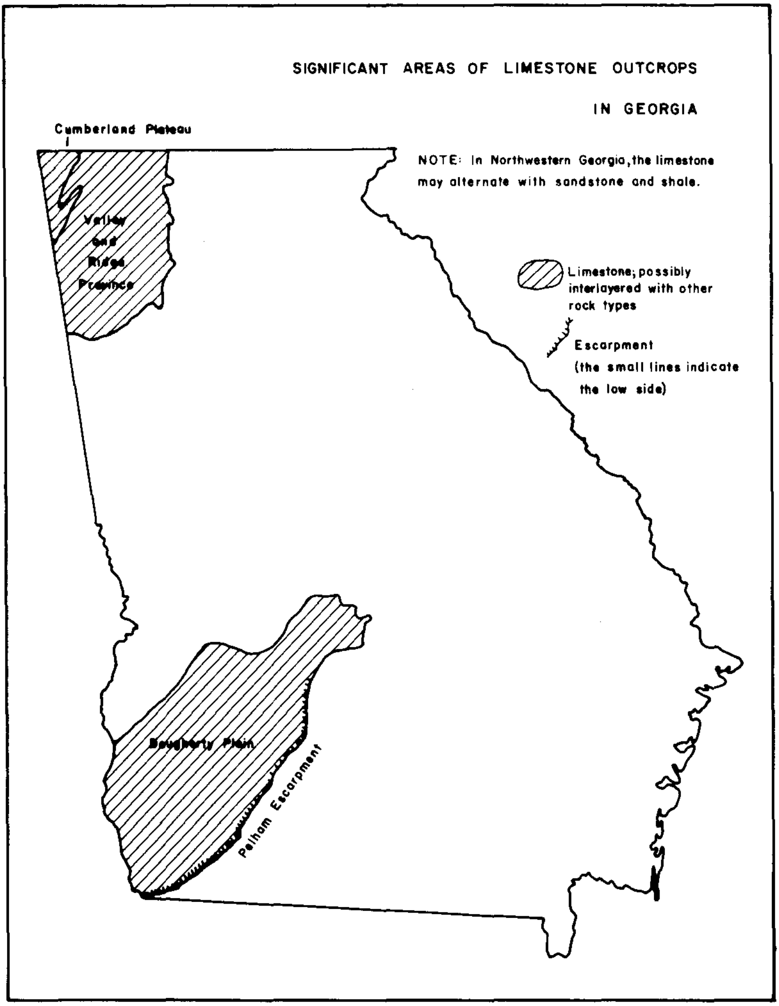

Figure 4. Limestone areas in Georgia.

acid helps attack the limestone, and reacts with it to change it into solubl products. The more carbon dioxide there is, the more limestone can b dissolved. We can write this reaction chemically as follows:

$$\underset{\text{carbon dioxide}}{CO_2} + \underset{\text{water}}{H_2O} \rightarrow \underset{\text{carbonic acid}}{H_2CO_3}$$

$$\underset{\text{carbonic acid}}{H_2CO_3} + \underset{\text{limestone}}{CaCO_3} \rightarrow \underbrace{\underset{\text{calcium ions}}{Ca^{++}} + \underset{\text{bicarbonate ions}}{2(HCO_3)^-}}_{\text{in solution}}$$

When bare limestone is exposed at the earth's surface, it is subject to the attack of rainwater weakly acidified by the small amount of carbon dioxide in the atmosphere. However, when rainwater percolates through the soil, it absorbs more carbon dioxide, which is formed by the decay of plant material. Thus, if the limestone is soil-covered, the acid attack is much more intense.

Climate also plays a role in this solution process. Cold water dissolves more carbon dioxide than warm water does. This is easy to visualize when you think of a can of soda. Warm soda fizzes a lot when opened (loses carbon dioxide), but cold soda does not, because it can hold more carbon dioxide in solution. It appears, as it did to some early geologists, that cavern formation would be more intense in cold climates. However, other factors counteract the basic temperature effect. In warm climates considerably more vegetation is present, and it grows all year around. Thus the soil is more carbon-dioxide rich. Also, in tropical climates considerably more precipitation is available to dissolve the limestone. Further, most chemical reactions proceed faster at warmer temperatures. Thus, the combination of all these factors makes the process of limestone solution much more intense in warmer climates.

Now that we understand the solution process better, let us look at how flowing water actually hollows out the limestone into caves. When precipitation falls on a porous rock layer, it soaks into the rock (infiltration) and seeps downward under the force of gravity. Most limestone is not porous, but is cut by numerous cracks called *joints*. Water seeps downward along these joints, eventually reaching a level where all fractures and openings are full of water. The upper limit of this water-filled zone is known as the *water table*. The water beneath the water table flows laterally and drains from the rock at low points, or springs. It is this lateral flow of ground water which forms caves.

When water first seeps into the limestone from the soil, it is very rich in carbon dioxide. It dissolves limestone rapidly, losing most, but not all, of its ability to dissolve. This rapid surface solution creates sinkholes and vertical shafts. However, when the descending water reaches the water table it can still dissolve more limestone. As it moves laterally in a thin zone just below the water table, it enlarges the cracks through which it is flowing. If one crack is somewhat larger, it transmits more water flow. The larger volume of water is capable of dissolving more limestone, so this crack grows faster than the others. As this process perpetuates itself, one crack eventually carries the vast majority of the flow and is enlarged into a cave.

The cave, then, is a water conduit. It collects water from one area through sinkholes or cracks in the limestone, and transmits it to another area through a naturally formed plumbing network. Most limestone caves form as a result of this water circulation. Their original hydrologic role frequently is obscured by the breakup of the cave into many isolated segments due to roof collapse, sediment buildup, or massive mineral deposition. Indeed, local valleys may deepen until the cave is left high above ground-water level, and totally dry.

Where might such conditions and processes take place in Georgia? Obviously, in areas where limestone exists. The two general areas of limestone outcrop in Georgia—one in the northwest, the other in the southwest—are made up of very different types of limestone (fig. 4).

The limestones in northwestern Georgia are very old—about 350 million years old. They are very hard and dense, and water can only move through them along joints. They frequently are exposed on the slopes of long mountain ridges; therefore, water entering the limestones must sink long distances downward before moving laterally. This area of Georgia contains many caves with deep pits, the result of solution by descending water. In fact, the deepest pit in the United States is in northwestern Georgia: 586 ft. deep, about the height of the tallest Atlanta skyscrapers. It is easy to see why cave exploring in this area must be approached with caution.

In southwestern Georgia the limestones are distinctly different. They are much younger—only 25 million years old—and they are much more porous. In between the pieces of shell and other grains are *voids*—pore spaces where water may move. This porosity is unusual for limestone. There also are joints which give the water even easier paths to travel. That area of Georgia extending from the southwest corner of the State through Albany to Dooly County on the northeast, and characterized by a relatively flat land surface, is known as the Dougherty Plain. It is underlain by these limestones. Within the limestones there are sinkholes and cavities. However, because the limestone is relatively flat and close to the level of the Flint River, which drains the area, most of these are water filled. The sinkholes can be seen on aerial photographs and on topographic maps. We know the caves exist here because water wells have intercepted them, and because large perennial springs in limestone, such as Radium Springs, usually are fed by flow from open conduits.

The eastern edge of the Dougherty Plain is marked by a long, low ridge variously known as the Curry Ridge or the Pelham Escarpment. This ridge is the edge of the overlying layers of rock, and here some limestone is exposed at slightly higher elevations. Thus, there are a few caves above the water table. It formerly was thought that the cave-forming process was principally responsible for eroding this ridge by dissolving it. However, more recent data on the caves conflicts with this idea.

Caves and Water Supply

Because caves are an integral part of water circulation in limestone, they obviously are closely related to water supply. In areas of karst terrain, water availability is often problematic. Most surficial water sinks rapidly into the ground along enlarged joints; therefore lakes and rivers are few in extensive karst areas. Beneath the ground the water is confined to a few large, open conduits because most limestones are dense and impermeable like those in northwest Georgia. Thus, surface-water supplies are almost nonexistent, and well-water supplies are a gamble. If a well intercepts a cave, water is bountiful; if it does not, the yield is very little or none. Cave explorers have provided valuable assistance to landowners by accurately mapping a cave so that a well may be drilled at exactly the right spot to intercept the water flow. The limestones in southwest Georgia and Florida are usually porous, and there, most wells have a high yield.

In karst areas, *ground water* (the geologic term for water which has seeped into the ground) is very different from ground water in other areas. Most usable ground water occurs in granular aquifers. An *aquifer* is a layer of rock yielding usable quantities of water, and a granular aquifer is such a layer made of grains, usually sand and gravel. The water moves slowly through a multitude of minute pores between the grains. It is everywhere. The velocities of ground-water movement in a granular aquifer are about several inches to 10 ft/day. Even the faster velocities are an exceedingly slow 0.00008 mi/hr. The slow movement of water through these small pores allows natural biologic and chemical processes to degrade pollutants and to purify the water. The minute pores also serve as sieves, straining out many pollutants. Thus, ground water in granular aquifers is naturally purified.

In contrast, ground water in karst areas is easily and rapidly contaminated. Because the water flows through large openings, it is little strained or filtered. For the same reason, it can move more rapidly—tens, hundreds, or even thousands of ft/day. This rapid flow transmits pollutants great distances before natural processes can purify them. Several well-documented instances are recorded in Missouri, a state noted for its caves and karst terrain (Aley, 1974). In one case, dye flushed down the toilet at a Springfield school showed up in a nearby city-park spring. It had travelled about 50 ft/day. In another instance, septic tank drainage near Doniphan, Mo., was traced to a nearby well in less than three days. Bacteriologic sampling of the well indicated the water unsafe for human consumption.

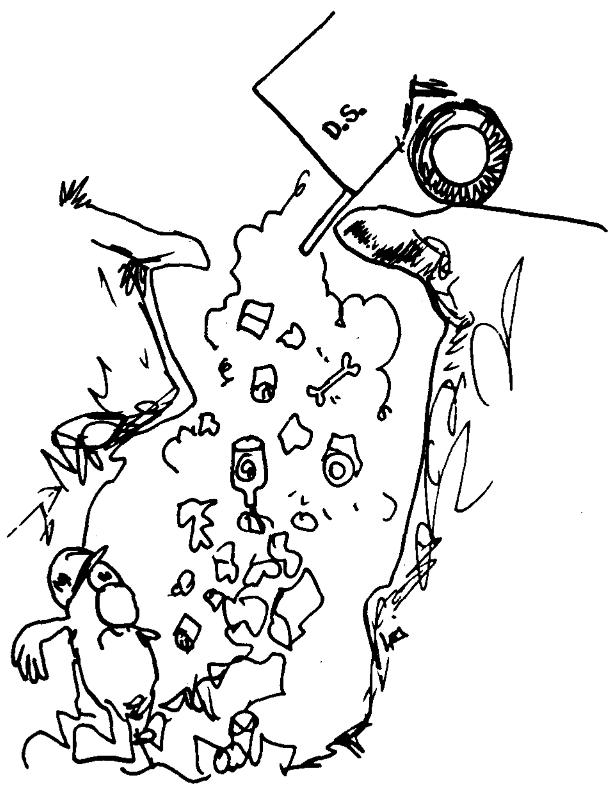

Figure 5. It is illegal to dump refuse in caves or sinkholes in Georgia. Cartoon by Charlie Loving.

Similar effects can be found in Georgia. Near Valdosta the Withlacoochee River disappears into a sinkhole. Wells in a broad area south-southwest of this point pump the highly colored "black" water, characteristic of south Georgia surface streams. "The recharged, highly colored water migrates rapidly downgradient and is withdrawn from wells before any natural filtering and color removal can occur. The migration from the recharge area is probably facilitated by channels or solution openings. . ."(Krause, 1976). In the northwestern town of Chickamauga, Crawfish Spring flows in quantities of 9 to 23 million gal/day from solution openings in limestones and dolomites (a rock chemically similar to limestone with magnesium added). However, wells in the Chickamauga area cannot be used for drinking water without expensive treatment, because of high bacterial counts probably originating from local septic tanks and transmitted rapidly through the same large solution conduits.

It has long been the policy of the Land Protection Branch of the Environmental Protection Division, Georgia Department of Natural Resources, to prohibit the dumping of wastes in sinkholes for exactly the reasons documented above. The Cave Protection Act of 1977 has solidified this policy into law:

> "It shall also be unlawful to dump, litter, dispose of or otherwise place any refuse, garbage, dead animals, sewage, trash, or other such similar waste materials in any quantity in any cave or sinkhole." (Sec. 6, Act No. 352 of 1977.)

Land Collapse in Karst Terrains

Collapse is an integral part of cave development. In many caves the floor is littered or piled high with what cavers call "breakdown" (blocks of collapsed material from the ceiling and walls). This process occurs in response to the constant pull of gravity whenever a portion of the ceiling is no longer able to support its own weight. This frequently happens as a passage grows wider, leaving the roof unsupported. It is particularly common in thin-bedded rocks and less common in more massive, stronger limestones.

A common mechanism of upward collapse is called *stoping* (pronounced with a long "o"). As one layer of rock collapses, it exposes the next layer above it to the inexorable pull of gravity. Eventually, this layer cracks and weakens, exposing the layer above. Of course, the process narrows upward since the edges of each layer are supported by the underlying layer and therefore tend to stay in place (fig. 6). This upward stoping collapse continues until either a strong layer is encountered or the surface is breached. In the latter case, a sudden catastrophic collapse may result. The hole formed is known as a collapse sinkhole in contrast to one formed by solution. Such land-surface collapse, or sudden subsidence, occurs naturally as a part of karst terrain development. However, it frequently is accelerated or triggered by man's activities. One obvious way this happens is by placing additional weight on the roof. This was vividly demonstrated by the City of Fort Gaines sewage treatment lagoon. The pond was located on top of the very porous Clayton Limestone, a relatively thin limestone outcropping in a narrow band in western middle Georgia. When the pond was filled with sewage, the bottom collapsed and the entire lagoon rapidly drained underground. The hole was plugged with concrete and the lagoon refilled. Again it collapsed. Again it was plugged. Eventually the bottom was stabilized, but only after considerable expense and probable ground-water contamination.

A frequent triggering mechanism for land-surface collapse in karst areas is a sudden change in underground water levels. Water exerts a buoyant, floating effect on the rocks immersed in it. Thus, part of the weight of a cave roof may be supported by this buoyancy. If the water level is lowered, either by pumping or by a drought, this support is removed. The roof may no longer be able to support its own weight and may suddenly collapse.

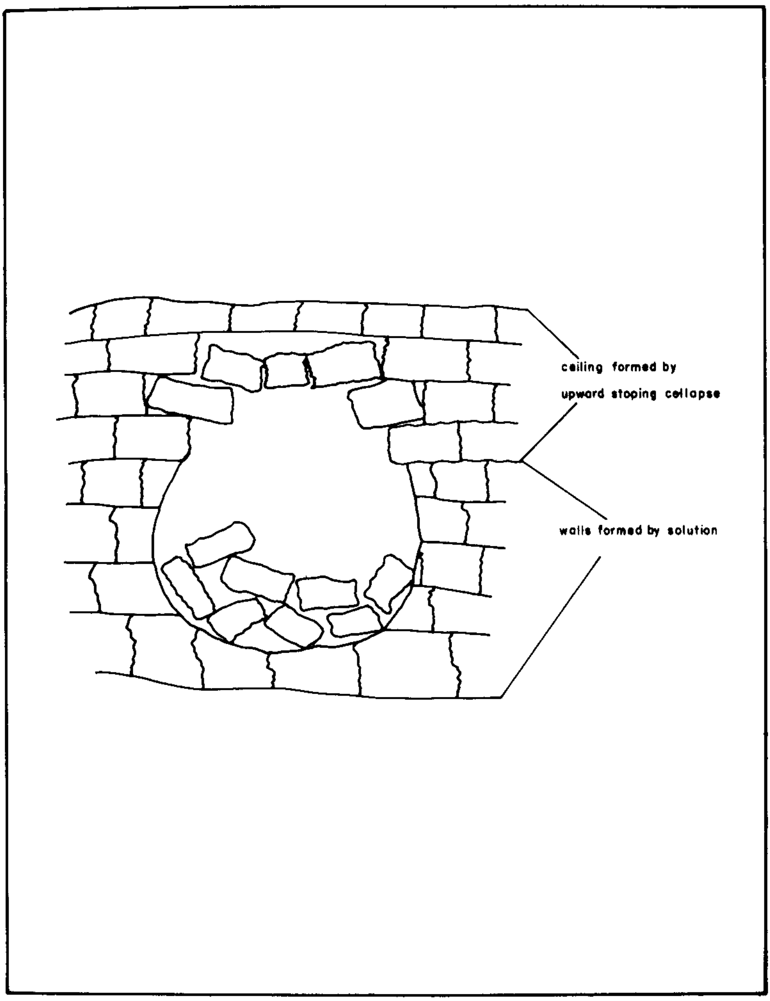

Figure 6. Cross section showing upward stoping of a cave ceiling.

Land-surface collapse does not necessarily have to be caused by the presence of a gigantic cave, however. In southwestern Georgia the limestone is overlain by a layer of residual sand and clay, ranging in thickness from 0 to 75 ft. This is material which was deposited as part of the limestone, but was not calcium carbonate—quartz grains, for instance. Since quartz is relatively insoluble, this material was left behind when the limestone dissolved. Thus, this residual layer indicates that hundreds of feet of limestone have dissolved here, leaving their insoluble components behind. The limestone surface below the sand layer is relatively porous and commonly contains small vertical tubes formed by solution at the intersection of two joints. These carry water downward. But, because the water can move rapidly down these open pipes, it can also wash some sand grains along with it. This creates a hollow in the unstable sand layer (fig. 7). The roof crumbles, and more sand is washed down the joint. The pocket continues to enlarge underground until the roof is too thin to support itself. Then sudden collapse occurs. This process may be accelerated or localized by man's alteration of the surface drainage, such as his directing more water to one area, thereby rapidly undermining it.

An example of this in Albany, Ga., was the collapse on the Banks Haley Art Gallery grounds. This area acts as a collection basin for storm-sewer runoff. Water from the surrounding area is funneled into the basin and pumped out through sewer lines. On June 6, 1973, during an exceptionally heavy rain, one of the pumps failed to function properly, causing several feet of ponded water to soak into the ground. This infiltrating water triggered a sinkhole only 50 ft. from the gallery itself. Although conditions favorable to the natural formation of sinks exist throughout much of southwestern Georgia, data gathered over a two-year period indicate that the areas of active sinkhole collapse are centered around man's activities (J. D. Wilson, written commun., 1975). Urban development, which increases runoff by paving large areas, and heavy water withdrawals in a concentrated area are two key triggering mechanisms caused by man.

Speleothems—Mineral Deposits in Caves

When erosional downcutting of the outlets lowers the water level in a cave to a point that air may circulate within it, the process of speleothem growth begins. *Speleothem* is the geologist's collective term for all types of minerals that are deposited in a cave. Actually, certain types of speleothems are deposited underwater, but this water is generally in contact with air in the cave.

Most speleothems are made up of the mineral calcite, which is crystalline calcium carbonate, the same mineral that makes up limestone. In fact, most speleothems are limestone redeposited in different forms. They accrete by reversing the same reaction which dissolved limestone. Remember that the soil has abundant carbon dioxide, much more than the air has. Thus, the water moving down into the ground becomes acidic, and dissolves limestone. However, when this water drips out onto the cave ceiling it comes into contact with cave air, which is similar to normal surface air. As a water droplet hangs on the cave roof, it slowly grows in size and loses carbon dioxide to the cave air. However, when this occurs, calcium carbonate must also be deposited, because the two are chemically balanced.

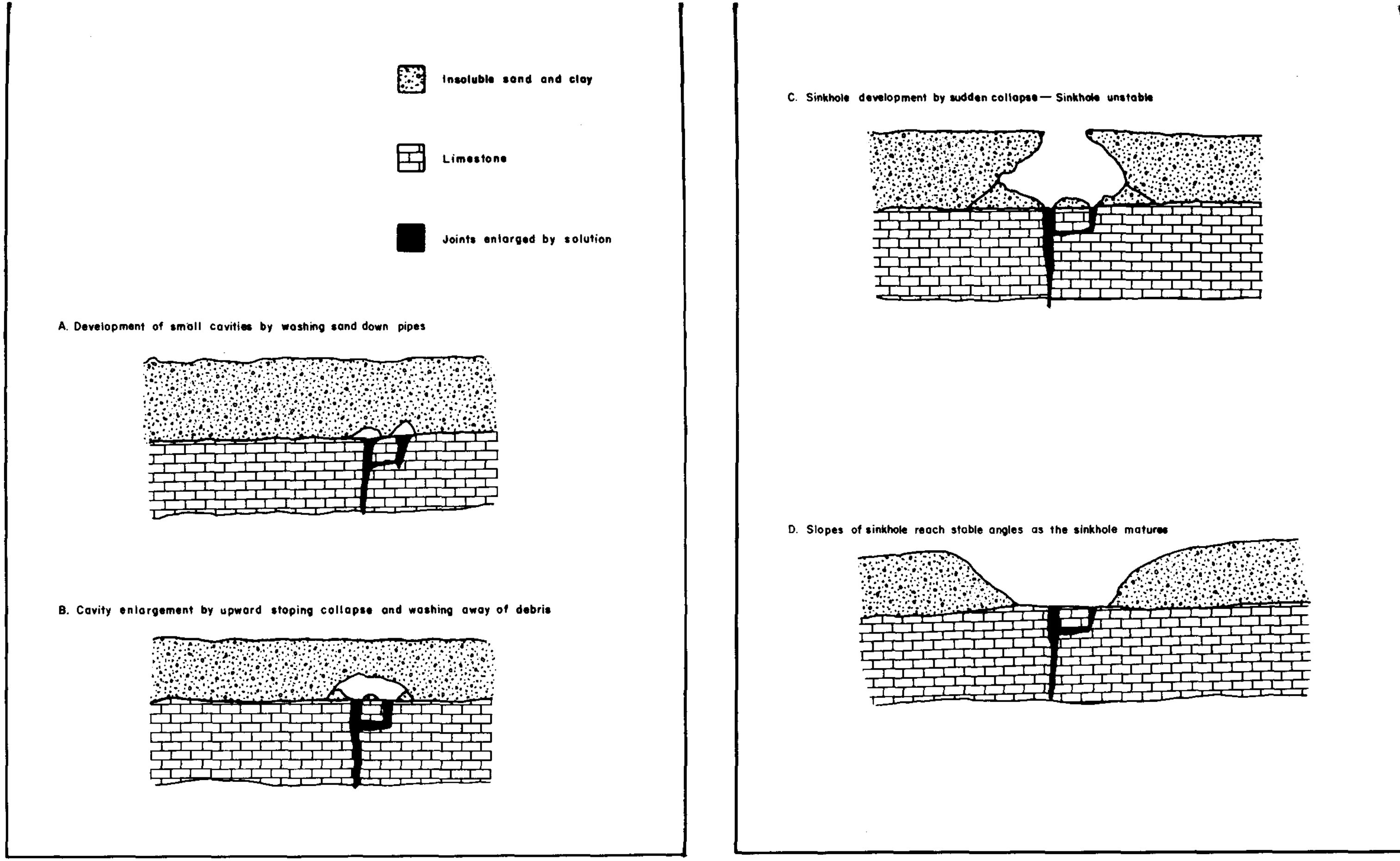

Figure 7. Cross section showing progressive development of a collapse sinkhole in south Georgia.

From what part of the water drop is the carbon dioxide lost? From the outside, of course. Then, where is the calcium carbonate deposited? In a tiny ring on the ceiling which marks the circle where the outside of the drop touched the roof. The next drop deposits another ring on top of the first one, and slowly a *stalactite* grows—a long, thin, hollow stalactite known as a *soda straw* (fig. 8).

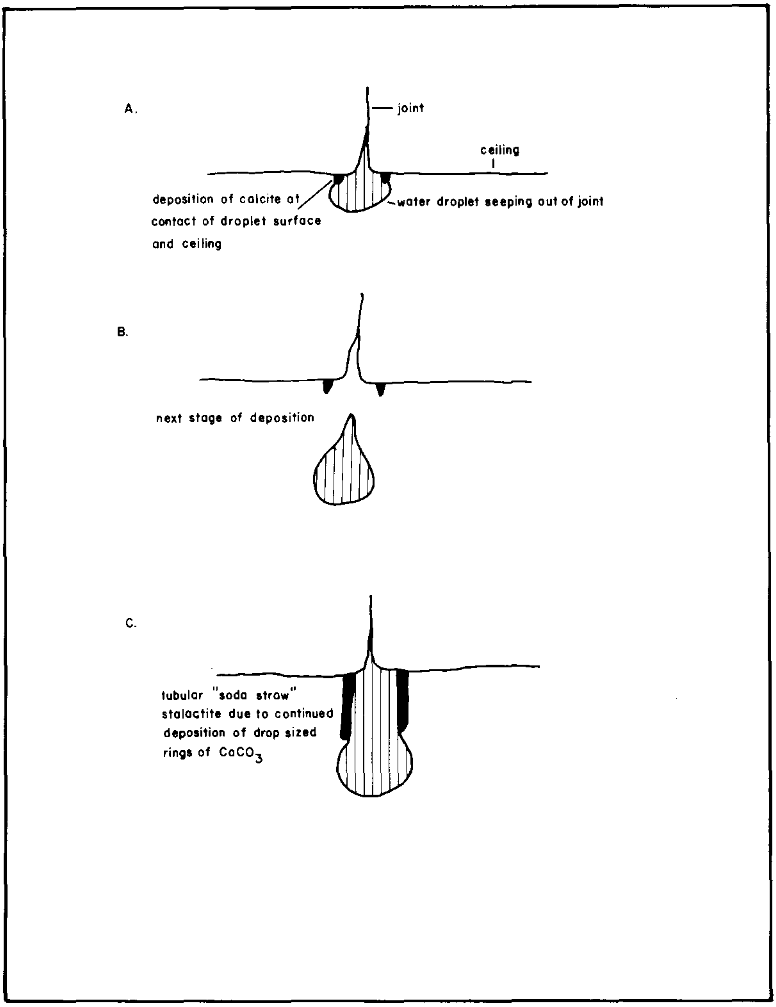

Figure 8. A soda straw stalactite grows by depositing calcite in a fine ring where the outer surface of the water drop touches the ceiling.

It is this basic reaction, a loss of carbon dioxide causing the precipitation of calcium carbonate, which causes the deposition of calcite speleothems. Evaporation has little effect in the damp cavern air. The speleothems form different shapes in response to the way the water flows, drips, or seeps as it deposits the calcite. If deposition from a soda straw slows down greatly,

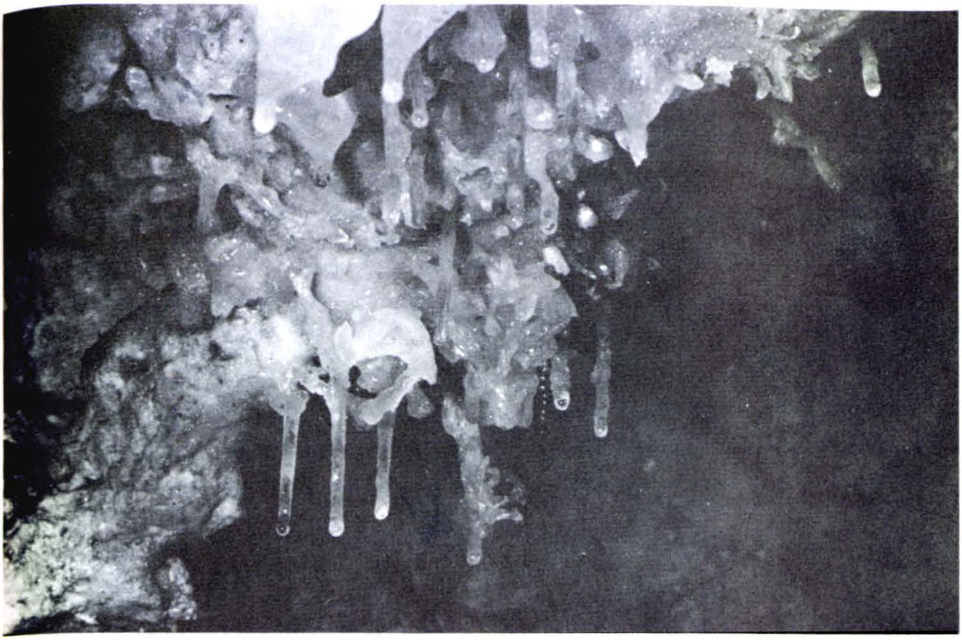

Figure 9. Soda straws. Note water drops. Photo taken in a Georgia cave by the author.

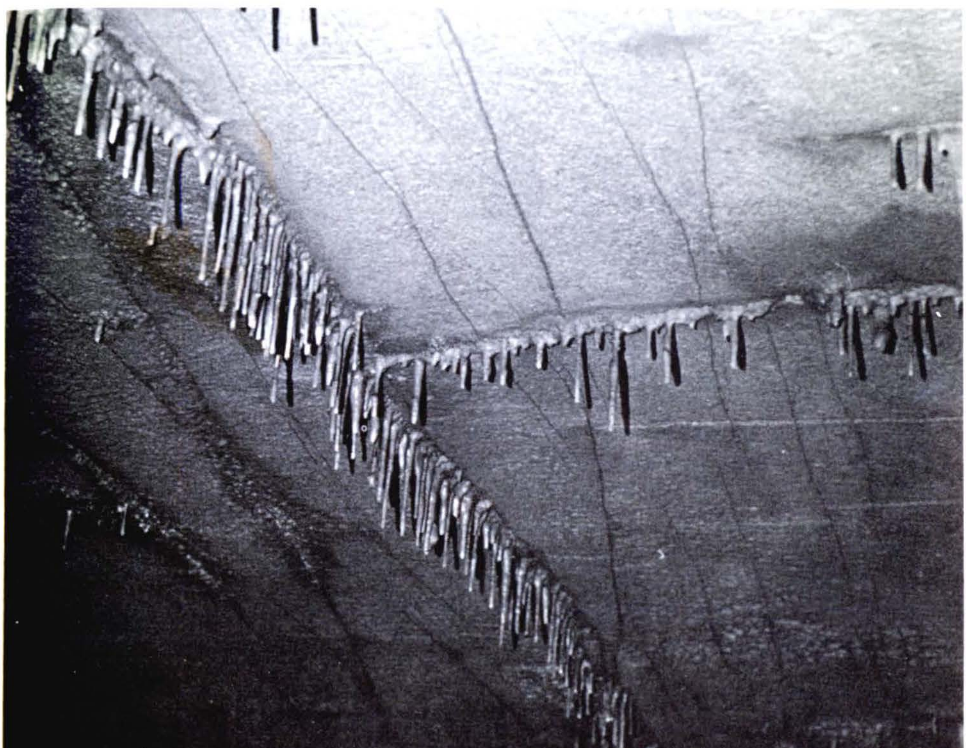

Figure 10. Localization of soda straws along joints in the limestone. Photo taken in a Georgia cave by the author.

crystals may form within the tube, blocking it from water flow. After this, water must flow down the outside and deposit its calcite around the initial straw, thus thickening it into the familiar icicle-shaped stalactite. After the water drips from the stalactite, it falls to the floor. Upon striking the floor it loses more carbon dioxide (if there is any left), and deposits a mound of calcite on the cave floor. This mound grows upward forming the familiar *stalagmite*. Eventually, the stalactite and stalagmite may grow together to form a *column* (fig. 11).

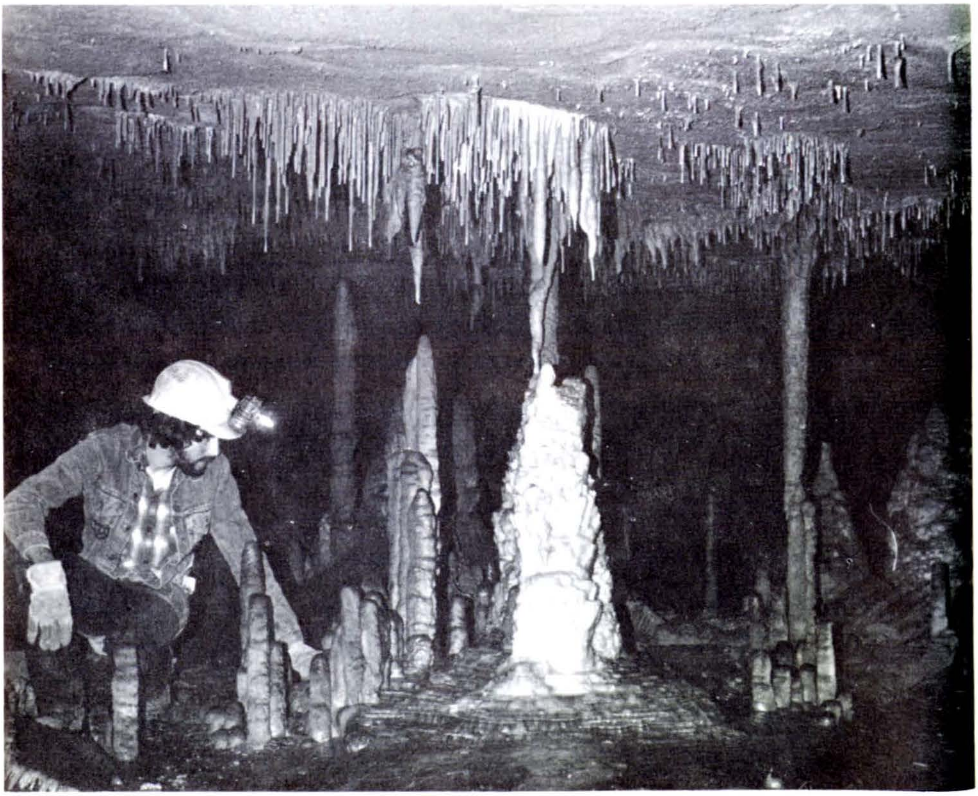

Figure 11. A cave explorer admires a forest of stalactites, stalagmites, and columns. Photo taken in a Georgia cave by the author.

The rate of this deposition varies. It depends on the amount of rainfall on the land above, the amount of vegetation present, the temperature, and other factors. Thus, the present growth rate of a stalactite cannot be used to determine when it started to form. As the climate has changed, the growth rate has changed, and the present rate probably is not typical. Indeed, different stalactites, side by side in the same cave, grow at different rates. It is known that they are exceedingly slow, however. One cubic centimeter of calcium carbonate per one-hundred years is a rough approximation. (A cubic centimeter is about the size of a marble.) Thus, massive stalactites, stalagmites, and other speleothems took many hundreds or thousands of years to grow. If broken, they cannot replace themselves in our lifetime, in our children's lifetime, or for many generations to come. They are essentially gone **forever.**

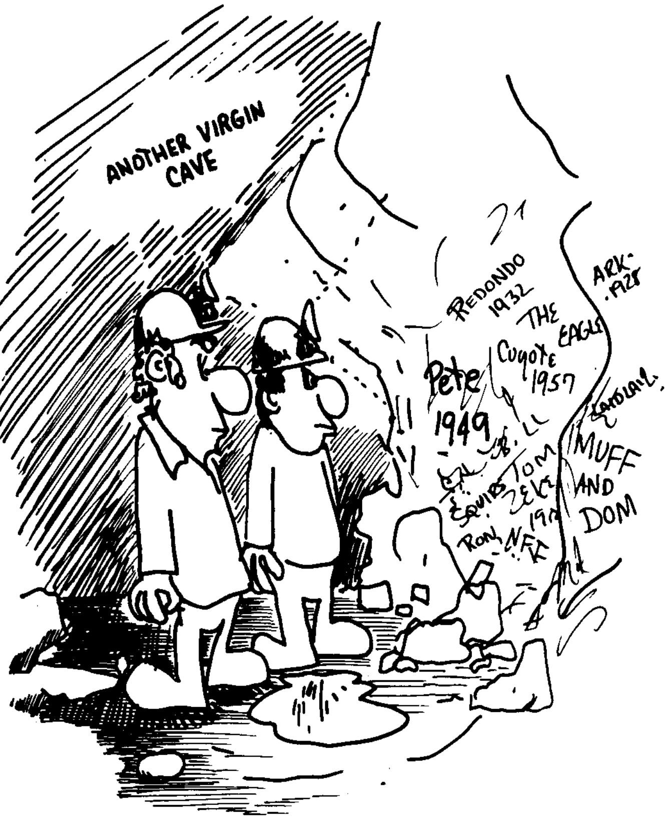

Figure 12. Even writing or marking on the walls destroys the natural, unspoiled beauty of a cave. Cartoon by Charlie Loving.

Cavers, therefore, have a very special responsibility to protect the environment they visit. Nature can restore the damage from a forest fire, or cover the scars of a strip mine in only a fraction of the time it takes to replace one broken stalactite. Conscientious cavers make it a strict rule never to break off or remove speleothems, even for collections. Writing or marking on them destroys their beauty, and even writing on cave walls ruins the natural, unspoiled environment of the cave. Speleothem specimens should only be collected for valid scientific research by professionals, and then collection should be minimal and as judicious as possible. The Georgia Legislature recognized the beauty and delicacy of speleothems in the Cave Protection Act of 1977. It is illegal to break or deface any speleothem, or even to remove a broken one from a cave. Further, it is illegal to mark on cave walls or to disturb the natural cave environment without written permission from the cave's owner.

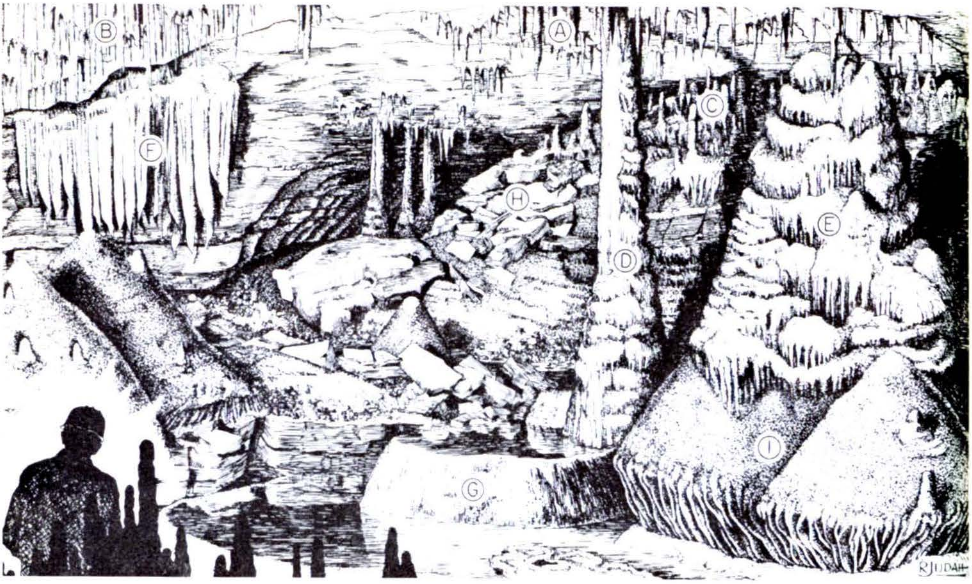

Figure 13. Idealized drawing of some common speleothems (sketch from Circular No. 8, Indiana Geological Survey, courtesy of J. B. Patton). A. stalactites, B. straw stalactites, C. stalagmites, D. column, E. tiered stalagmite, F. draperies, G. rimstone, H. breakdown, I. flowstone.

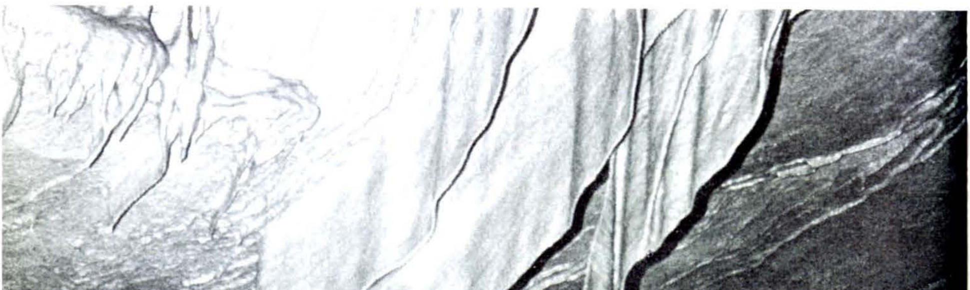

Figure 14. A cave explorer admires curtains in a Georgia cave. Photo by Ed Brock.

Now let us look at some of the other types of speleothems that give a cave such beauty (fig. 13). If water seeps down the cave wall, flowing in a thin, broad sheet, then a broad, layered coating builds up. This type of deposit is called *flowstone*. It frequently looks like a frozen waterfall. If water trickles down a sloping roof in a thin trail, then a thin, winding trail of calcium carbonate builds up. This forms long, thin, ribbon-like deposits through which light frequently can be seen. Impurities between the layers give this deposit a banded appearance and, thus, its common name, *bacon* (fig. 14). When long and wavy, this deposit is sometimes called *curtains* or *drapery*.

In some caves the floor is the site of a flowing stream. When this water flows over an obstacle, it is agitated. It loses carbon dioxide, just as soda does when it is agitated by shaking. The cave stream, then, deposits calcium carbonate, making the obstacle higher and agitating the water more. Thus, a *rimstone dam* is built up, frequently dividing the stream into long, flat pools separated by short, vertical drops over the dams (fig. 15).

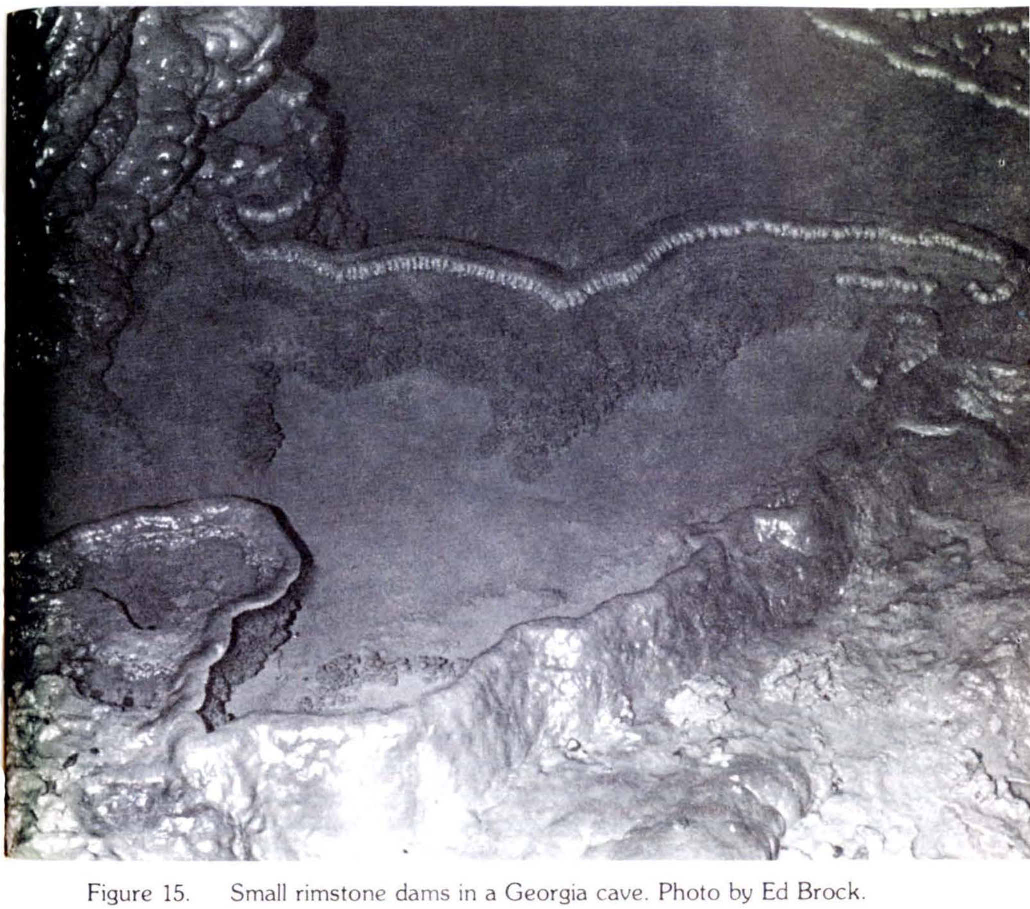

Figure 15. Small rimstone dams in a Georgia cave. Photo by Ed Brock.

The most bizarre-looking common speleothems probably are *helictites*. These are weirdly curving stalactite-like growths of calcite resembling petrified tangles of spaghetti (fig. 16). They grow sideways and even upward, sometimes circling back on themselves in response to unknown forces of crystallization and with apparent disregard for gravity. There even are *heligmites*, bizarrely growing upward. What mechanism causes these unusual growth patterns is an enigma to *speleologists* (scientists who study caves).

Figure 16. Helictites and heligmites in a Georgia cave.

Some of the rarer cave deposits are *cave pearls* and *dogtooth spar*. Cave pearls are concentric layers of calcium carbonate deposited around some grain which acts as a nucleus (fig. 17).They are found in shallow pools usually beneath rapidly dripping stalactites. They generally take a spherical shape when they are small, although they may become irregular as they get larger. If many of these are crowded together, they may take more angular shapes. In caves on Isla Mona (Mona Island), off the west coast of Puerto Rico, there are pockets of cave pearls, some with perfectly cubic shape. In some Mexican caves there are cave pearls the size of heads of cauliflower, and with much the same outward appearance. One of the interesting aspects of cave pearl growth is that, crowded together, they grow into spherical shapes without becoming cemented together or to the cave floor. The bottom of the pearl is as round as the top. One of the reasons that cave pearls are so rare probably is because, being pocket size and not cemented down, they are easily removed by vandals.

Figure 17. A nest of cave pearls in a Georgia cave. Photo by the author.

The other type of unusual speleothem is *dogtooth spar*: individual crystals of calcite in their characteristic hexagonal pyramid shape. These crystals form under very slow moving or standing water at a surface where there is free air above to allow carbon-dioxide outgassing. Small calcite crystals frequently can be found in the quiet pools behind rimstone dams. In the Black Hills region of South Dakota, entire caves were refilled with water, and large spar crystals were deposited on both the walls and ceiling.

Not all speleothems are composed of calcite, although the vast majority are. Many different minerals have been recorded from caves, but most of these are very rare. Probably the second most common speleothem-forming mineral is gypsum—calcium sulfate ($CaSO_4$). Gypsum commonly occurs as fine needle-like crystals or as delicately curving "flowers" (fig. 18). *Gypsum flowers* are one of the most beautiful of the speleothems, with several pristine white "petals" of gypsum all curving out gracefully from a single point. Gypsum occurs where cave air is very dry because it precipitates from water due to simple evaporation. Gypsum flowers apparently crystallize within pores in the wall as the water evaporates. The force of the growing crystals pushes the previously formed gypsum ahead of it. Thus, they grow from the base, not from the tip. Faster crystal growth in the center gives the gypsum its delicate, outward curves.

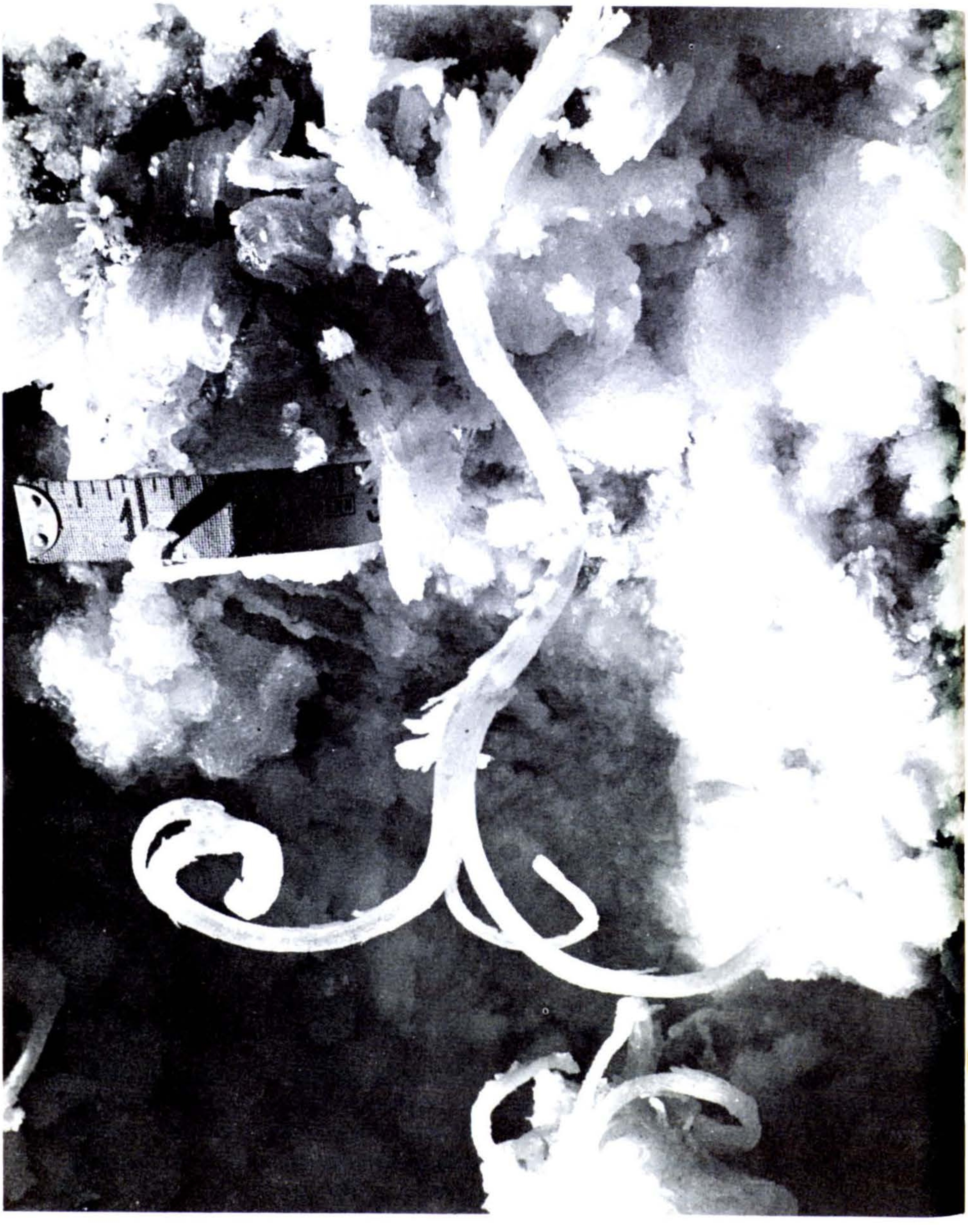

Figure 18. Gypsum flower. Photo courtesy of Charlie and Jo Larson. Copyright 1980 by Charlie and Jo Larson, Vancouver, Wash.

All of these different speleothems may be seen in Georgia caves. You may notice that none of the photographs accompanying this section tell specifically where they were taken. Most caves known well to the general public are bare, desecrated, and littered. All that remains of speleothems is stumps and pieces on the floor. The walls are covered with names and the floor, with trash. That caves, and particularly speleothems, are delicate and irreplaceable cannot be overemphasized. For this reason, it is hoped that the reader will find caves with the guidance of experienced, conscientious cave explorers. The motto of the National Speleological Society sums it all up:

> *"Take nothing but pictures, leave nothing but footprints, kill nothing but time."*

Cave Animals

Speleothems are not the only rare and unusual features of caves. Witness the *troglobites*. These are animals who have lived for countless generations in the cold, wet, austere darkness of caves. They are pale or colorless: of what use is color in total darkness? They are blind, even eyeless: what can be seen in total darkness? They have evolved extra-long antennae and limbs and other modifications improving their only sensory ability—that of feeling their environment. They have evolved exceptionally slow life styles, seldom eating and using little energy, for food is a scarce commodity in the lightless, plantless world of caves. Some speleobiologists believe that troglobites may compensate for this by living exceptionally long lives. Imagine—crawfish over 50 years old!

Biologists divide cave animals into three types: trogloxenes, troglophiles, and troglobites, or so to speak—cave visitors, cave lovers, and cave prisoners. *Trogloxenes* are those animals who briefly visit the cave, generally just inside the lighted entrance. Raccoons may use the entrance for a den, or snakes may stay in its coolness during the heat of the day. These are temporary residents—here today, gone tomorrow, and except for bats, of limited interest.

Troglophiles are the cave lovers. They particularly like the cool, moist, dark environment of the cave, and may spend their entire lives there. However, they equally well might spend their lives in some other cold, dark, damp place, like under a rock. Many types of salamanders typify this class (fig. 19); cave crickets also belong here.

Troglobites are the true cave dwellers. They have evolved for this life; they cannot leave. What chance would a slow, blind, white crawfish have in a surface stream (fig. 20)? It would make excellent fish food. But in the cave environment, where it often is the largest, and usually the ultimate predator in the food chain, it exists quite satisfactorily. However, cave crawfish population is controlled, not by predators, but by available food supply and the energy necessary to find it.

It is a principle of biological evolution that over millions of years, organs not used disappear, and those used develop. They do not develop in response to needs, rather the individual or the species continues to exist if the right organs develop by chance. This random change is known as mutation—

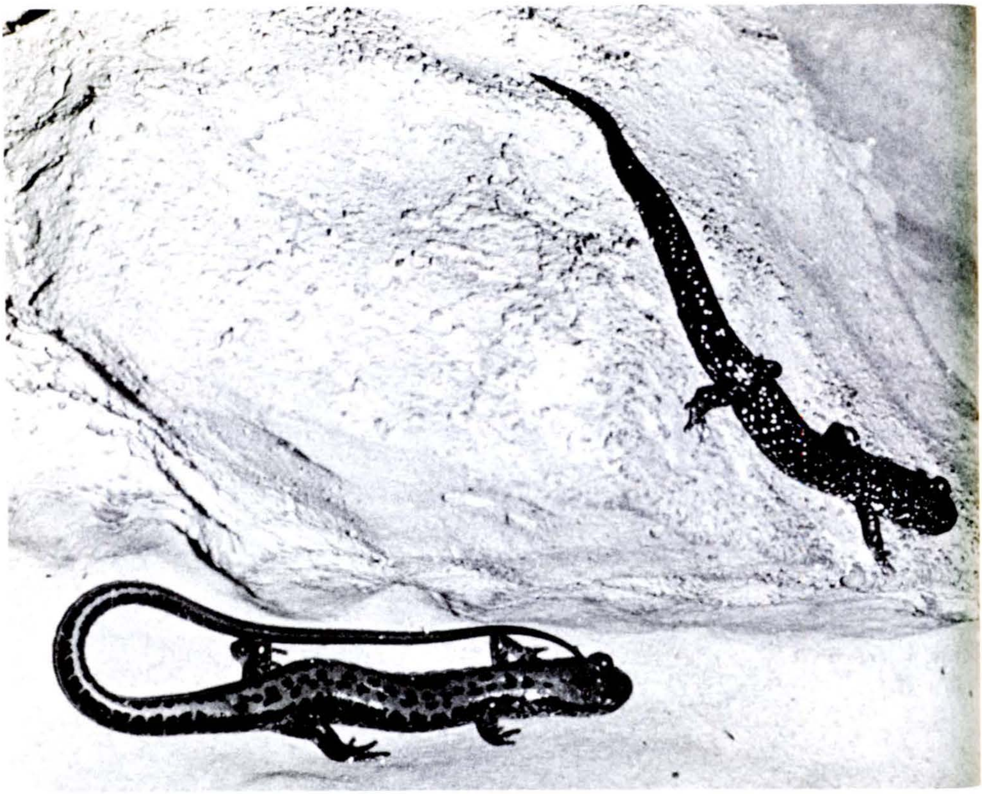

Figure 19. Two visiting salamanders on the wall of a Georgia cave. The left one is a Red-Backed Salamander and the right one is a Slimey Salamander. These are common trogloxenes in Georgia. Photo by the author.

Figure 20. Two troglobitic crayfish, *Cambarus hubrichti* (left) and *Orconectes pellucidus* (right). Neither is found in Georgia. Sketch by John Cooper from "A Guide for Biological Collecting in Caves" by John E. Cooper and Thomas L. Poulson, 1968, published by the National Speleological Society.

changes in the gene structure which are not due to heredity. Thus, if by chance an eyeless crawfish is born in a surface stream, it probably dies very soon afterward, never to mature and breed. However, if such a crawfish is born in a cave, it grows, matures, breeds, and passes on its newly changed genes to its offspring. An advantageous characteristic or gene change, such as elongated antennae, tends to predominate. The crawfish with the better sense of feel preferentially survive in the darkness, while the "normal" ones die out. Gradually, over countless generations, these characteristics breed their way into the population. But how about the disadvantageous changes such as the loss of sight? Generally, biologists believe that negative mutations vastly predominate over positive ones and, that if an organ has no positive benefit, it eventually disappears. So, over millions of years, troglobites lose their sight and coloration, slow down their life style and consumption of food, and develop elongate tactile sensors (feeling agents).

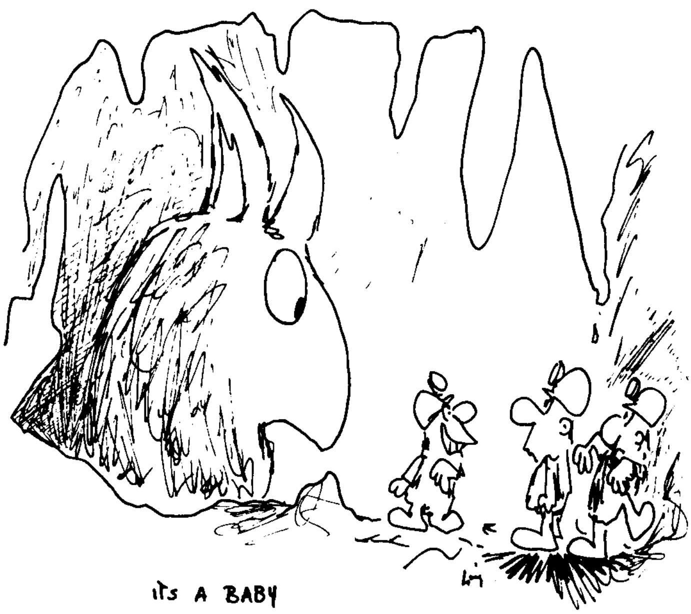

Figure 21. Many unusual animals have evolved for life in caves. Cartoon by Charlie Loving.

One of the most common animals associated with caves, and one of the least understood, is not a troglobite, but a trogloxene, a temporary visitor who must spend part of his life outside the cave—the bat. Many different species of bat are found in the United States and several of them are on the Endangered Species List. Bats are mammals, just like mice, squirrels, cows, and humans. However, they have evolved wings for more rapid mobility. They have also evolved a remarkable system of echo location, like sonar, so that they can sense obstacles in total darkness.

Almost all bats are highly beneficial to man. Bats generally feed on three types of food: insects, fruits, or plant nectar. Most of the bats in the southeastern United States are insectivores. They play an important role in controlling the insect population. The Big Brown Bat may consume up to 1,000 insects per hour. The total population of Mexican Free-Tailed Bats in Texas is estimated to consume from 7,000 to 20,000 tons of insects every year. Since bats may hunt up to 50 miles from their roosting site, it is plainly evident that bats play a very beneficial role in the local ecology.

Because of a very bad image (the bat needs a public relations man), and because of the threat of rabies, bats often are persecuted or exterminated. They rarely attack people, but they do bite if pursued. A person bitten by a bat should try to take the bat with him and see a doctor immediately. Only from the bat's head can a doctor tell if it is rabid. Bats' beneficial aspects far outweigh their detriments, however, and they should be protected and left alone.

Figure 22. The famous vampire bat lives only in South and Central America. Most bats in the southeastern U.S. eat insects and are highly beneficial. Cartoon by Charlie Loving.

One of the biggest dangers to bats is disturbance during the winter. Bats, like bears, must hibernate during the cold weather when no food is available. They build up a layer of fat and then go into a state of virtual suspended animation, reducing their heartbeat and other vital signs almost to a standstill. If they are awakened from hibernation, their life processes accelerate and their body uses up food reserves much faster than it should. Because there is no food in the wintertime, a bat awakened from hiberation may well die of starvation before the warmth of spring returns. Certain caves are preferred hibernation spots for bat colonies, and several of these, where endangered species of bat hibernate, have been declared "off-limits" by the National Speleological Society. Their members voluntarily avoid these caves during the winter to give the bats a chance to survive. One of the endangered species of bat, the Indiana Bat, lives in some Georgia caves.

Many other fascinating cave animals are found in Georgia. One of the most common and easily seen is the cave cricket (fig. 23). Cave crickets do not closely resemble their surface counterparts. They are generally brown and yellow and have longer limbs, marked by hair-like extensions, and antennae that may be longer than their body. They are frequently seen on cave walls near entrances. In some localities biospeleologists have found that they leave the cave at night to feed; in other areas they seem to find enough food within the cave.

Figure 23. A cave cricket, another common trogloxene found in Georgia caves. Photo by the author.

Troglobitic vertebrates (animals with backbones) are extremely rare in Georgia caves (fig. 24). The Tennessee Cave Salamander and the Southern Cavefish, both cave-adapted species, have been seen in north Georgia caves. In addition, a different type of troglobitic salamander which is highly adapted, having very small, non-functional eyes and reduced pigmentation, as well as a troglobitic crawfish (an invertebrate), have been recorded from some south Georgia caves. Many other smaller troglobitic invertebrates have also been noted.

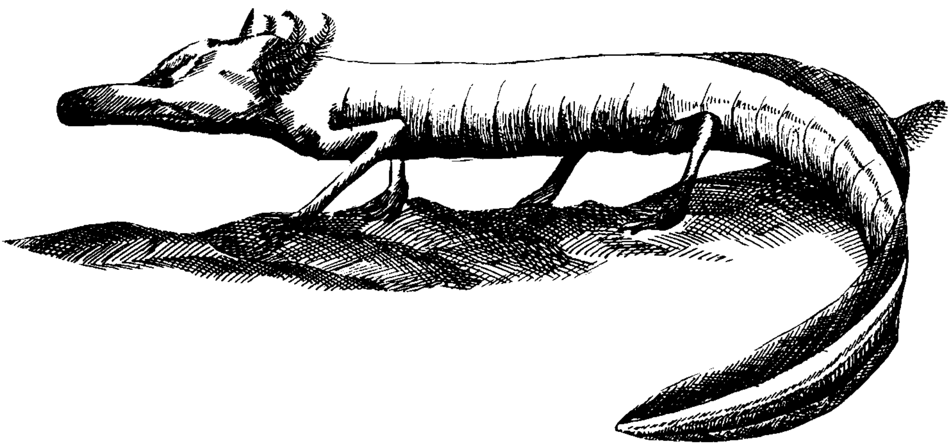

Figure 24. The Texas Blind Salamander, *Typhlomolge rathbuni,* most specialized of the troglobitic salamanders. Sketch by Susan Lindstedt from the *N.S.S. News,* Feb., 1979.

Troglobitic animals frequently evolve a population confined to a single cave or a small, interconnected group of caves. Their numbers are minimal. Any disturbance to them or their environment may reduce their breeding population below the minimum number necessary to maintain the species. They should be collected only by conscientious scientists, and then only when the population is obviously large enough. The Cave Protection Act of 1977 makes it unlawful to kill, harm, or even disturb any wildlife found in any cave—even if you own the cave.

Figure 25. It is illegal to harm any wildlife in any Georgia cave. Cartoon by Charlie Loving.

Cave Exploring

What is it like to go cave exploring away from the paved walkways and bright lights of commercial caves? It is cold—approximately 56° F. in north Georgia caves, a bit warmer in south Georgia. The caves maintain a constant temperature generally equal to the average annual temperature of the land above. There is **no** light. Photographic film left open in a cave for weeks is not the slightest bit exposed. And, in most caves, it is damp. The floor is generally muddy. Occasionally, you have to wade or swim in pools or streams of crystal clear, cold water. Quite frequently, you have to lie on your stomach in the mud and crawl forward, your face almost pressed to the ground, because the ceiling is so low.

At other times you will be in big, wide open rooms. You will have to climb or descend steep walls or rock piles. Cavers must be familiar with basic rock-climbing skills (figs. 26 and 27). In some areas there are pits—yawning chasms disappearing into the blackness below. Smooth, vertical or overhung walls make them almost impossible to climb. For these, cavers use special climbing ropes and technical climbing equipment, much of it especially developed for use in caves (fig. 28).

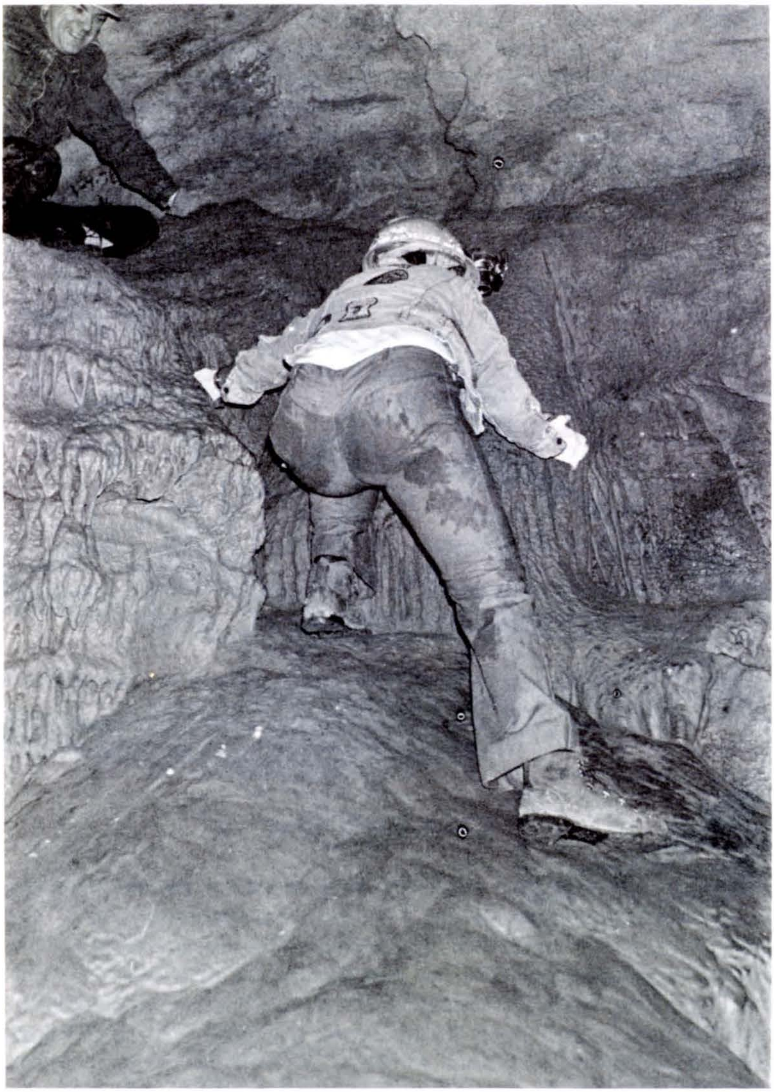

Figure 26. A cave explorer frequently needs to know some basic rock-climbing skills. Photo by the author.

People explore caves for various reasons. It is good, strenuous exercise. The beauty of speleothems can be truly breathtaking. It is dangerous and challenging. It is different, totally different, from any other part of your life. Caves are an untouched, unspoiled environment. Once in a great while a caver has the opportunity to enter "virgin" passage, a place where no one else has ever been. But, even if others have preceded you, the thrill can still be there. If it is your first time, then it is "virgin" to you.

Figure 27. Chimneying is the process of holding your body between two close walls by simultaneously pushing against both sides. Photo by the author.

But caving can be dangerous. You can get lost, especially if your light goes out. The danger of any minor accident is magnified many times if you are deep underground, far from help, and in places difficult to reach or to get out of. Remember that caves develop as part of the hydrologic system, and that caves containing streams are commonly subject to rapid flooding. Most serious caving accidents involve climbing. Many involve novices attempting to climb into or out of a pit with unsafe rope and inadequate techniques and experience.

But cavers do not have to be unprepared for the dangers of the cave. Organized cave explorers have developed a relatively brief set of guidelines for safe caving. First and foremost, never go caving alone. A group of four is ideal. Too many gets slow and crowded, and too few cannot cope with emergencies. Always tell someone where you are going and when you expect to be back. Give yourself a margin for delays. Then, be back by the prescribed time or notify those expecting you of a change of plans. Leave the phone number of the local cave rescue team, if one exists. Northwest Georgia has its own Cave Rescue Team, a branch of Walker County Civil Defense. They can be reached 24 hours a day through the Lafayette Police Department, 404/638-1717.

Figure 28. Special techniques are necessary for negotiating deep vertical pits. Note that the climber is attached to the rope with several climbing cams; he is **not** climbing hand-over-hand. Sketch by Jayne Gorup, from Assoc. for Mexican Cave Studies Bull. 7, 1977.

Always wear a hard hat with a chin strap to keep it securely in place. This should be a miner's type hat or a climber's helmet (a short motorcycle helmet will also do). Weaker "bump caps" or army helmet liners do not stand up to heavy blows. The hard hat not only protects your head from low ceilings, which are a common problem, but more important, it protects you from rocks dislodged by another caver climbing above you. It only takes a small rock falling 30 or 40 ft to seriously injure you.

Figure 29. Always wear a hard hat. Cartoon by Charlie Loving.

Always carry three separate sources of light, each one capable of getting you out of the cave. Your main light source should be mounted on your hard hat to leave both hands free for climbing. Either electric headlamps or carbide lamps are available for the helmet. Electric lamps usually have a wire which goes to your belt where a six-volt battery is carried. Carbide lamps are self-contained on your hat. A small reservoir of water drips on calcium carbide which generates acetylene gas; this gas is burned as a small flame in the center of a polished reflector. Carbide lamps give off a broad, diffuse light. They make your cap a bit front-heavy, but they avoid the clumsy wire which hangs from the electric light and catches on things. On the other hand, the electric lamp gives off a narrow, concentrated, and much brighter beam.

Perhaps the deciding factor in most cases is expense. Electric or carbide lamps cost about the same. However, 25- to 50-cents worth of carbide lasts all day, whereas a six-volt battery for the same period costs about $2.50 at current prices. Many cavers now use rechargeable batteries.

Your second source of light should also be functional under caving conditions. A good waterproof flashlight which can be hung around your neck is an excellent spare. Candles and waterproof matches are useful if the candle is slow-burning and is mounted so that you can carry it and still exit from the cave. However, since your hat-mounted lamp is your preferable light source, you should always carry spare parts and fuel (batteries or carbide and water) for it. In the case of a carbide light, you also need to have a small plastic bag to carry out the spent carbide. This used-up carbide is now calcium hydroxide, a close relative of lye, and is not only unsightly when dumped, but also highly toxic to cave life.

And above all, use common sense when caving. Know your limitations. Do not overextend yourself. On your trip into the cave, turn around often, particularly at passage junctions, and look at the scene as you will see it when you are coming back out. Never mark directions on the wall; if you need markers, draw them in the mud or use plastic arrows and pick them up on the way out. If momentarily disoriented, stop and think carefully. Then try to retrace your steps to the way out. If hopelessly lost, stop and sit tight. Conserve your light. If you have left word, someone will soon be looking for you.

The techniques for negotiating vertical pits cannot be taught satisfactorily in this small booklet or, in the author's opinion, by any book. They are highly technical, complex, and dangerous. In other areas of caving, danger can be minimized, but in pit climbing, one slip can be fatal. These techniques should be learned from experienced cavers. They should be practiced repeatedly out-of-doors in the light. Then, they should be attempted on small drops—about 30 to 50 ft. After one is both comfortable with his personal climbing system and in shape for extended strenuous exertion, he or she can move on to deeper and more exciting pits. Above all, never attempt to climb into or out of a pit hand-over-hand. This is deadly. These cautions are particularly apropos in Georgia, for northwest Georgia is the site of the deepest cave pit in the United States: 586 ft! Numerous other deep pits are located both in Georgia and in neighboring areas of Alabama and Tennessee.

National Speleological Society

Most experienced, conscientious cave explorers are members of the National Speleological Society (the N.S.S.), a nationwide organization of cave explorers and cave scientists dedicated to the study, conservation, and safe exploration of caves. The address of the national headquarters is:

National Speleological Society
One Cave Avenue
Huntsville, Alabama 35810

Local chapters, called grottos, are located around the country. Cavers are generally gregarious, fun-loving, hearty, out-door oriented people. Newcomers are usually welcomed. Most grottos have sporadic novice trips to moderately easy caves specifically organized for beginners.

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The N.S.S. headquarters can send you information on local grottos and a membership application. The current annual membership fee is $15.00 ($10.00 for students) for which you receive 12 issues of the **N.S.S. News**, a monthly newsletter of nationwide caving activities, and four issues of the **N.S.S. Bulletin**, a quarterly scientific journal dedicated to caves. But, most important, you also get an opportunity to help explore, study, and conserve the unusual natural resources that are caves.

Presently, there are three active grottos in Georgia and several in adjacent areas of neighboring states. The largest and most active in Georgia is the Dogwood City Grotto in Atlanta. Others are in Athens (the Athens Speleological Society), and Macon (the Middle Georgia Fall Line Grotto). The company-sponsored Wedixie Grotto in Atlanta is not open to the public. An informal group of cavers exists in southwestern Georgia; if they should organize a grotto its official address would be available from the N.S.S. office as soon as it is chartered. A telephone call rather than a letter to a grotto officer is the most efficient and definite way of getting information on meeting times and places. The following names and addresses of grottos in and near Georgia are those most current at press time of this publication. A change in any of this information can be obtained from N.S.S. headquarters.

National Speleological Society Grottos In and Near Georgia

Athens Speleological Society
P. O. Box 742
Athens, GA 30601

Chattanooga Grotto
c/o David Durham
6647 Botsford Dr.
Chattanooga, TN 37421

Dalton Grotto, Ga.
(inactive)

Dogwood City Grotto
c/o Steve Logan
4122 Fawn Lane SE
Smyrna, GA 30080

Middle Georgia Fall Line Grotto
c/o Douglas R. Noble
Museum of Arts and Sciences
4182 Forsyth Rd.
Macon, GA 31210

Florida State Cave Club
c/o J. K. Osmond
U-6885, Florida State University
Tallahassee, FL 32306

Fort Rucker-Ozark Grotto (FROG)
c/o Mary Ann Kelley
144 Oakland Circle
Fort Walton Beach, FL 32548

Wedixie Grotto (company-sponsored, not open to the public).
c/o Ron Teet
Dept. 423231, Western Electric Co.
6701 Roswell Rd. NE
Atlanta, GA 30328

West Georgia Grotto (inactive)
West Georgia College
Carrollton, GA 30117

The Cave Protection Act of 1977

The Cave Protection Act of 1977 includes several sections which have not been mentioned yet. In order to make this coverage complete, the entire Act is summarized below in brief layman's terms. For a strict legal interpretation of the Act, consult a lawyer.

Section 1.	Title: The Cave Protection Act of 1977.
Section 2.	Explains that caves and their contents are unusual and important, and defines the policy of the State and the intent of this Act to be their protection.
Section 3.	Defines terms used in the Act.
Section 4.	Makes it a misdemeanor to damage speleothems in any way or to disturb the natural condition of any cave or to tamper with any cave gate, without the written permission of the owner.
Section 5.	Prohibits the sale or export for sale of speleothems obtained without the owner's written permission.
Section 6.	Prohibits anyone, even owners, from dumping refuse in any quantity in sinkholes or caves.
Section 7.	Makes it a misdemeanor for anyone, even owners, to catch, disturb, or harm wildlife in any cave. It allows scientific collector's permits.
Section 8.	Absolves the owner of any cave from all liability for any accidents which may happen to cave explorers or cave scientists who have asked permission to enter a cave and have not been charged an entry fee. (Those without permission are trespassers to whom the owner owes only the limited responsibility not to intentionally harm them).
Section 9.	In the event that one or more sections of the Act are declared unconstitutional or invalid, the remaining provisions remain in effect.
Section 10.	Repeals conflicting laws except those dealing with criminal trespass or property damage.

The Act, which became effective July 1, 1977, is Final Act No. 352 of 1977. Landowner liability (Section 8) is the only significant portion of this Act not explained in detail and is mentioned below.

Caves on Private Property or State or Federal Land

Most caves in Georgia and the eastern United States are located on private property. In most cases the owner is far more interested in farming or grazing than he is in his cave. Most owners object strenuously to trespassers. Further, many cave owners have been wary of law suits which might result from accidents in their caves. To avoid the damage often caused by thoughtless visitors, and to avoid the possibility of legal action, many cave owners have "closed" their caves by gating or blasting them shut—or by shooting at trespassers.

Figure 30. Someone messed up landowner relations again. Cartoon by Charlie Loving.

In order to maintain access to caves on private property, cavers must pay close attention to the owner's wishes. Therefore, obtain permission before entering private property. Walk around fields, close gates that were closed, climb fences only at strong points, avoid littering, park the car out of the way, and avoid frightening the livestock. If you come out of the cave at a reasonable hour, tell the owner you are safe, and thank him. Stop and chat about the cave. Tell him why it is interesting; better still, send him any pictures you may take. Let the owner know that you, too, care about the land.

Since the passage of the Cave Protection Act of 1977, Georgia cave owners may no longer be held liable for accidents which happen to cave explorers. This applies even if an owner has checked a caver's credentials

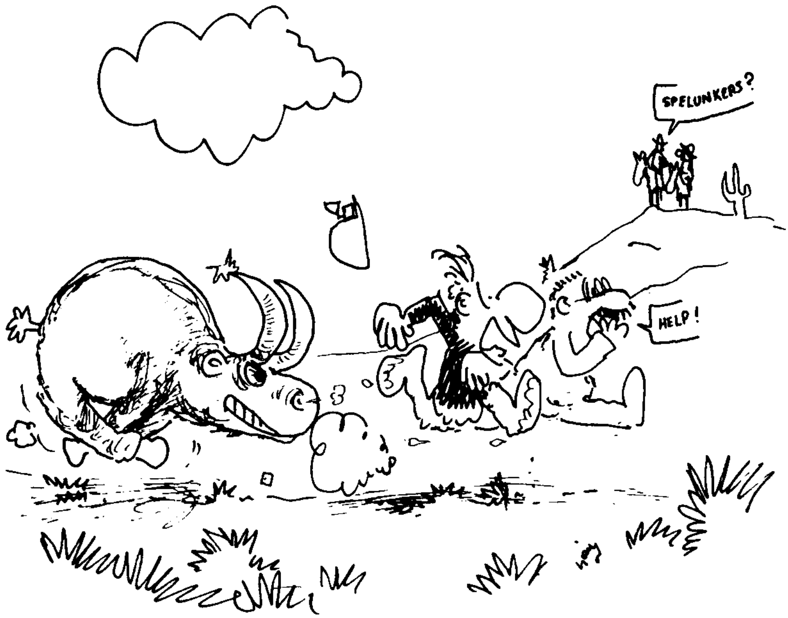

Figure 31. Try not to excite the landowner's livestock. Cartoon by Charlie Loving.

(experience, equipment, N.S.S. membership, etc.). It also applies to lessors, officials, employees, or any designated agent of the owner, whether the owner be an individual, corporation, municipality, or the State.

Some caves may be located on state-owned property, either in state parks or on wildlife management areas. A permit is required to enter a cave in a Georgia state park,and advanced reservations are requested. Groups may be from 3 to 12 members, one of whom must be an experienced caver. Each person must have a hard hat, three light sources, a litter bag, suitable clothing and foot gear, and matches in a waterproof container. Each party must have 100 ft of safety rope and a first-aid kit. The ranger checks equipment before issuing a gate key. Damaging speleothems, writing on the walls, littering, or collecting **any** specimens is, of course, prohibited.

Because some of the caves on wildlife management areas contain deep vertical pits, the entrance policy is more stringent. Cavers not only have to apply for a permit 30 days in advance, but each party member must list his experience in vertical caving and the type of equipment he plans to use. Each trip member's safety gear and extra climbing equipment are checked on site by a ranger prior to his issuing the key.

There may also be some caves located within the many national forest areas in Georgia. Although a specific policy for entering caves does not exist, it is wise to check with the forest headquarters if there is any doubt.

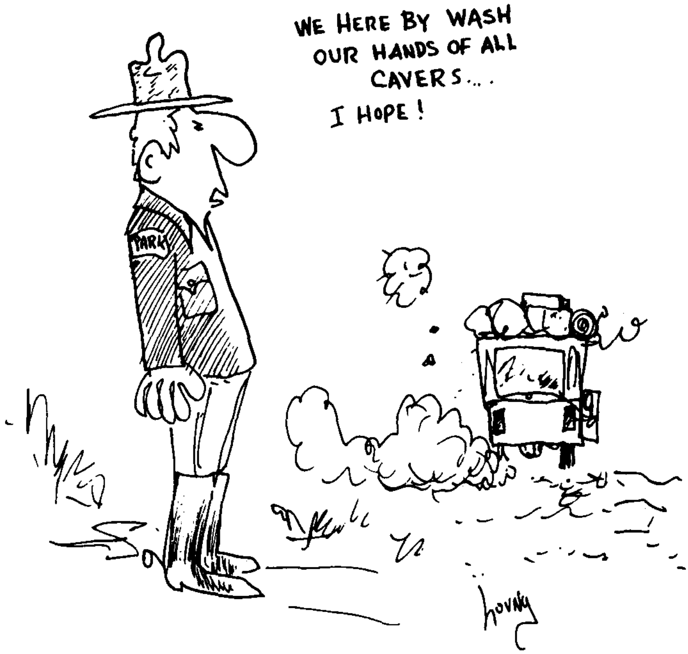

Figure 32. Georgia State Parks have a strict policy on cave exploring. Cartoon by Charlie Loving.

Commercial Caves in the Georgia Area

If caves interest you, but you are not quite sure if you want to grovel in the mud, try out one of the nearby commercial caves. There are none in Georgia, but there are several very nice ones in adjacent areas of Tennessee, Alabama, and Florida. The following list is provided through the cooperation of the National Caves Association, the nationwide organization of commercial cave operators. It may not be complete, and is not meant as an endorsement of caves on the list or as a criticism of any caves inadvertently left off the list.

If you work with youth groups and you are interested in taking them caving, try Cumberland Caverns at McMinnville, Tenn. This is about an hour's drive north of Chattanooga. They have an exciting cave program, especially planned for young people. The group not only takes the commercial tour but also goes beyond the lights and trails—with a guide, of course. They follow this up with camping overnight inside the cave. The heavy gear is hauled into the cave by jeep through a rear entrance. Of course, a fee is charged, and advance arrangements are absolutely necessary.

Commercial Caves in the Georgia Area

Alabama
- DeSoto Caverns, Childersburg
- Manitou Cave, Fort Payne
- Monte Sano State Park, Huntsville
- Rickwood Caverns State Park, Warrior
- Russell Cave National Monument, Bridgeport
- Sequoyah Caverns, Valley Head

Florida
- Florida Caverns State Park, Marianna
- Ocala Caverns, Ocala

Tennessee
- Bell Witch Cave, Adams
- Bristol Caverns, Bristol
- Caverns of the Ridge, Solway
- Cedars of Lebanon State Park, Lebanon
- Crystal Cave, Chattanooga
- Cudjo Caverns, Cumberland Gap
- Cumberland Caverns, McMinnville
- Forbidden Caverns, Sevierville
- Jewel Cave, Dickson
- Lost Sea, Sweetwater
- Natural Bridge (& Cave), Waynesboro
- Ruby Falls, Chattanooga
- Ruskin Cave, Dickson
- Tuckaleechee Caverns, Townsend
- Wonder Cave, Monteagle

Figure 33. Cartoon by Charlie Loving.

Supplementary Reading

The following books on various phases of speleology and cave exploring may be of interest to you. They are no substitute for learning from experienced teachers. The list is not intended to be exhaustive and no endorsement of any book is implied by its mention on this list.

Many of these books are available at your local bookstore. However, almost all of them may be purchased by mail from the N.S.S. Bookstore at the N.S.S. office, or from **Speleobooks**, P. O. Box 333, Wilbraham, Mass., 01095 (free catalog).

General Books on Caves

Caves, by Tony Waltham, 1974, Crown Publishers, New York, N.Y. $12.50, hardbound. A broad coverage, well illustrated.

The Caves Beyond, by Joe Lawrence, Jr., and Roger Brucker, reprinted 1975, Zephyrus Press, Teaneck, N.J. $5.25, paperback. The story of a major early exploration effort by the N.S.S.

Discovery at the Rio Camuy, by Russell and Jean Gurnee, 1974, Crown Publishers, New York, N.Y. $6.95, hardbound. Narrative of exploration in a large tropical cave. Available from the authors, 231 Irving Ave., Closter, N.J., 07624.

Depths of the Earth—Caves and Cavers of the United States, by William R. Halliday, 1976, Harper and Row, New York, N.Y. $14.95, hardbound. Combines narratives and introductory cave science; a very broad coverage.

The Jewel Cave Adventure, by Herb and Jan Conn, 1977, Zephyrus Press, Teaneck, N.J. $5.95, paperback. A personal narrative of exploration and discovery in a major cave system in the United States.

Under Plowman's Floor, by Richard Watson, 1978, Zephyrus Press, Teaneck, N.J. $7.95. A novel about a man who discovers caving and how it absorbs him. Excellent.

Carlsbad, Caves, and a Camera, by Robert Nymeyer, 1978, Zephyrus Press, Teaneck, N.J. $14.95. Fascinating stories and pictures of early caving in New Mexico.

The Longest Cave, by Roger Brucker and Richard A. Watson, 1976, Alfred A. Knopf, New York, N.Y. $12.50, hardbound. Narrative of explorations culminating in the connecting of two caves to make the world's longest cave. Absorbing reading.

The World of Caves, by A. C. Waltham, 1976, G. P. Putnam's Sons, New York, N.Y. $12.95, hardbound. World-wide coverage of caves; introductory science; profusely illustrated.

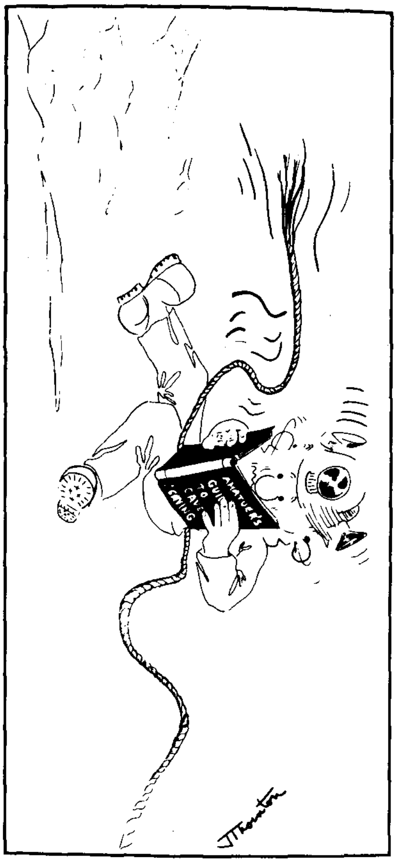

Figure 34. Cave exploring techniques can only be learned from experience and practice, not from books alone. Cartoon by Thornton, courtesy of the *N.S.S. News*.

How-To Books on Cave Exploring

The Amateur's Guide to Caves and Caving, by David McClurg, 1973, Stackpole Books, Harrisburg, Pa. $3.95, paperback. Extensive coverage for beginners; prepared in cooperation with the N.S.S. Out-of-print, but check your library.

American Caves and Caving, by William R. Halliday, 1974, Harper and Row, New York, N.Y. $10.00, hardbound. Coverage on techniques, equipment, and cave science with anecdotes. Of interest to both novices and experienced cavers; very detailed.

Cave Exploring, by Jennifer Anderson, 1974, Association Press, New York, N.Y. $4.95,paperback. Very elementary and now out-dated.

The Speleo-Guide, by John Slaven, 1971, published by the author, P.O. Box 3521, Visalia,Ca. 93277. $3.50, paperback. A very broad survey, but not detailed. Now very much out-dated.

Books on Speleology, the Science of Caves

Cave Minerals, by Carol A. Hill, 1976, The National Speleological Society, Huntsville, Ala. $15.00, hardbound. A somewhat technical, but profusely and beautifully illustrated coverage.

Karst, by J.N. Jennings, 1971, MIT Press, Cambridge, Mass. $8.95, hardbound. Technical, but on an introductory level; broad.

Karst Landforms, by Marjorie Sweeting, 1973, Columbia University Press, New York, N.Y. $25.00 hardbound. Technical, broad,well illustrated; reader should have background in geology.

The Life of the Cave, by Charles Mohr and Thomas Poulson, 1966, McGraw-Hill, New York, N.Y. $4.95, hardback. Profusely illustrated coverage of cave biology in layman's terms. Out-of-print, but most libraries have it.

The Science of Speleology, by T.D. Ford and C.H.D. Cullingford, eds., 1976, Academic Press, London, England. $29.50, hardback. Thorough, but highly technical; for professional scientists; covers both biology and geology.

Speleology, the Study of Caves, by George Moore and Brother G. Nicholas, reprinted 1976, Zephyrus Press, Teaneck, N.J. $4.50, paperback. Introductory, in layman's terms; broad; some areas recently revised.

Geology and Biology of Pennsylvania Caves, by William B. White, and John R. Holsinger, 1976, The Pennsylvania Geological Survey, Harrisburg Pa., 17125. White's treatment of the geology and hydrology of caves is not restricted to Pennsylvania and is well written, but it requires some technical background. Well worth the $2.00.

Acknowledgements

Credit for all photographs and diagrams is noted in the captions. If none is noted, they are by the author. All cartoons, unless specifically noted otherwise, are from "My Daddy was a Caver" by Charlie Loving, Speleo Press, P.O. Box 7037, Austin Tx., 78712 ($1.25 PP.) It contains many caving cartoons in addition to those used herein.

Much of the organization and many of the ideas used in this booklet were stimulated by a slide-tape presentation on caving prepared by a committee of members of the Dogwood City Grotto, including the author.

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3. Wilson, J. D., 1975, Georgia Geologic Survey, Department of Natural Resources, Albany, Georgia.