VERY SMALL AND ECLECTIC CAVES: CONSERVATION AND MANAGEMENT ISSUES

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ABSTRACT

Many caves throughout the world are small and unusual, in contrast to extensive cave systems developed by karst processes. Small and eclectic caves typically go unnoticed by most cavers, speleologists, and the general public at large. However, in many cases, these caves are geologically, historically, and archeologically significant. Many are pseudokarstic and have formed by interesting genetic processes. Non-traditional caves are typically studied by individuals who are particularly fascinated with them or who live far from larger, more "exciting" caves. There are hundreds of small caves that have histories proportionally larger than their size. Small and unusual caves are often located in highly populated areas and are frequented by the local population, often by children. Many have been environmentally stressed; graffiti painted on walls and excavation and removal of materials from caves are common problems. Moreover, in some places, lesser caves may be obliterated during construction projects. The best means of protection of small and eclectic caves is through stewardship and education. Management of these features presents unique challenges, as there is often a lack of local interest in preserving them. However, if their significance is demonstrated through educational and outreach activities, local stewardship may result.

Introduction

Most caves of interest to the public at large, scientists, speleologists, and cavers are of considerable size, typically hundreds of feet to miles in length, with rooms and passages that are voluminous, or of considerable depth. In general, the larger and more extensive a cave is, the more attention it receives for exploration, study, or visitation. The literature on caves reflects this as well. There are many books, articles, and other writings that discuss superlative caves, yet there are relatively fewer accounts about the lesser caves of the world. Small caves, many of which are inconsequential in the eyes of most people, including members of the speleological community at large, rarely receive the attention that they may merit. However, in many cases, these caves are geologically, historically, and archeologically significant. Many are pseudokarstic and have formed through interesting genetic processes. There are instances where the lesser caves have been described and studied by persons who are fascinated by their attributes or their histories, either in the genesis of the caves, or with regard to human interaction over the years. It has been said that often the speleogenetic and human histories are proportionally larger that the dimensions of these caves. Small, eclectic caves are often in remote locations and thus infrequently visited. Some receive attention by cavers and speleologists only because these people live far from the larger, more traditional, and more exciting caves found in well-known karst regions.

Like larger caves and virtually all other natural features, small caves are impacted by environmental stresses, especially those induced by human activity, including economic development, construction, and poor land-use practices. These impacts lead to heightened concern about conservation and preservation of natural resources. Moreover, conservation and preservation issues naturally lead to questions of management of natural resources as a protective measure. In this grand scheme of awareness of resources, recognition of impacts that threaten them, and pro-active attention to their management, small and eclectic caves have their niche.

In order to best address the conservation and management of lesser caves, it is best to define several parameters that are applicable to the geological aspects of these landforms and to their interaction with human activity. It will then be possible to conceive of ways to promote an appreciation for them and to ensure that they will be preserved for the future.

On the Definitions of Karst, Pseudokarst, and Cave

Karst - Karst is an internationally recognized term that refers to an assemblage of landforms that have been produced primarily by the dissolution of bedrock. Chemical processes are therefore predominant and the excavation and sculpturing of rock is carried out by flowing water. The result is a sculpted and/or pitted bedrock surface on exposed bedrock or the top of bedrock that is mantled by soil. Openings in the bedrock, such as pores and fractures (namely joints or faults) have been enlarged by the dissolutional process as groundwater circulates within the rock mass. This aqueous environment leads to a myriad of landforms, including (1) caves with a wide range of length, depth, chamber dimensions, and geometric complexity, (2) springs that are typically discrete and have large discharges in comparison to those in non-karstic terranes, (3) sinkholes, natural or anthropogenic, where surficial material has been dissolutionally or mechanically conveyed into and through the karstic aquifer beneath the surface, and (4) sinking streams and blind valleys where the entire discharge from these channels enters the ground at discrete localities. Karst systems are inherently non-uniform (highly anisotropic) with spatially variable porosity and permeability. Discharge of groundwater through and from karstic aquifers is highly variable and the flow dynamics are very responsive to changes in the hydrology on the surface. Thus, changes in groundwater flow through karst are rapid as conditions of seasons and weather (particularly storms) change.

There are five requisites for the formation of karst: (1) Bedrock must be soluble in water, usually water that is mildly acidic and contains carbonic acid derived from the atmosphere or soil. Most karst forms in carbonate rock (limestone, dolostone, or marble) or in sulfate rock (gypsum), all of high solubility in natural waters. However, under the right conditions of geochemistry and climate, karst may develop in less soluble rock such as granite or quartzite that are very rich in silica. In the latter case, some interesting eclectic caves are prime examples as discussed later. (2) Bedrock must be porous and permeable. There must be openings that can accommodate the presence of water (porosity) and these must be connected in such a way that water can migrate among them and provide continuous paths of flow (permeability). In karst these openings are either pore spaces formed when sedimentary beds were laid down (primary porosity) or as fractures such as joints or faults that formed as a result of structural deformation of the bedrock at a later time (secondary porosity). (3) The water must be chemically aggressive. Pure water can dissolve rocks such as the carbonates or sulfates; however, the process is considerably enhanced where the water is mildly acidic (carbonic acid derived from carbon dioxide in the atmosphere or soil or less commonly sulfuric acid in certain localities). (4) The land surface in karst terranes must have higher and lower elevations such that water entering as recharge in the uplands will flow to points of discharge (mostly springs) in the lowlands. This topographic relief provides a hydraulic gradient that is necessary to maintain flow of water through the aquifer and the transport of dissolved material. (5) As with all geologic processes time is an important factor. The rate of formation of karst is rapid in comparison to many other geologic events, but nonetheless, the process is slow from a human perspective.

Caves and other karst features have many different geometric configurations including the sizes and orientations of passages and rooms and the overall patterns of the arrangements of these openings in three-dimensional space. There are four general factors that modify the process of dissolution as caves and karst progresses: (1) Rock layers vary in mineral composition, texture, and thickness, collectively known as the lithostratigraphy. How will a rock unit develops caves and karst depends on these conditions. Generally speaking, a bed of rock that is relatively pure in soluble content (such as calcite in the case of limestone) will develop larger or longer openings (greater caves). Conversely, relatively insoluble beds will result in caves considerably reduced in size and extent (forming some of the smaller, eclectic caves as described later). (2) Geologic structure is highly important as a modifying factor. Nearly all cavernous rocks have been deformed by stresses in the Earth's crust (tectonism). Deformation results in the tilting or folding of units of rock and produces fractures (joints and faults) that vary in size, orientation, and distribution depending on the magnitude and direction of forces during the tectonic history of an area. The size, orientation, extent, and cross-sectional appearance of cave passages and rooms are guided by the tectonic setting in place at the time of dissolutional excavation. Groundwater flow is guided along structurally deformed beds and through fractures produced by tectonics. It follows that openings (caves) enlarged by dissolving of the bedrock will likewise be guided by structure. (3) Geomorphic processes of weathering, erosion, and deposition continually modify the surface of the Earth. Accordingly the elevations of uplands and stream valleys change with time. Slopes change. Karstic cave systems typically develop at elevations governed by the position of the water table prevailing at the time. As the topographic evolves with time, water tables will respond. If the landscape is lowered by stream erosion, water tables will also be lowered as will the elevations of cave development. Typically caves in an area of stream erosion and incision that are at higher elevations are older than those that are lower in elevation. This results in the higher caves being left as relict landforms, often resulting in interesting eclectic varieties. (4) The flow of groundwater is highly variable in rate (discharge) and degree of turbulence. The depth to which groundwater circulates may vary greatly, resulting in different degrees of hydrostatic pressures. Under high pressure and steep hydraulic gradients, the chemical and physical processes of speleogenesis may be accelerated and caves of considerable depth may form.

Pseudokarst - Pseudokarst includes landforms that morphologically resemble true karst, but are produced by processes that generally do not involve the dissolution of bedrock. Pseudokarstic features can also produce sculpted or pitted landscapes. Openings such as caves are produced largely by physical or biological mechanisms as opposed to chemical processes that predominate in true karst. Pseudokarstic caves are of great variety in size and shape and may be found in vastly different geologic or geographic settings. Pseudokarstic sinkholes are produced primarily by suffosion (a geomorphic term) otherwise known as piping (an engineering term) whereby particles or grains are physically sapped and transmitted through the subsurface to be expelled elsewhere on the surface. Most pseudokarst occurs in isolated localities and these features may be largely unique. Pseudokarstic processes may or may not involve the flow of water either on the surface or in the subsurface.

Cave - The definition of the word "cave" is variable and depends on the perspective of the person using the term. To illustrate this point, the following definitions are compiled and summarized from published definitions in lay and professional glossaries and dictionaries and from established usage by the global community of cavers and speleologists and the vast literature that they have produced.

The **Dictionary Definition of cave** is based on a composite of perceptions by the lay public as written in standard dictionaries of the English language. The definition is as follows: *"A cave is a hollow space or chamber, underground, hollowed-out in the Earth or in the side of a hill, cliff, or mountain: It is produced in limestone by running water, with an opening to the surface."* Note that there is no mention that the opening must be a natural one.

The **Caver Definition of cave** is based on a composite of perceptions by cave explorers and their collective community. It may be summarized as follows: "*A cave is a natural opening in the ground that meets any or all of the following: (1) Longer than X feet or meters in length or deeper than Y feet or meters, (2) Long enough that a person can go beyond the range of being able to see daylight at the entrance, or (3) formed in carbonate or sulfate rock (limestone, dolostone, marble, gypsum, and the like.).*" Note that this definition varies greatly with respect to the geographic regions or with the mindset and interests individual cavers. Therefore the values of X and Y in the definition vary accordingly. This definition is largely tied to the degree of explorational difficulty that a cave may have for the caver; very small (short or shallow) caves provide little challenge and are often ignored as being caves. Also, this definition ignores the type of rock that is host to the cave.

The **Geologic Definition of cave** is based on a composite of definitions in published glossaries in the professional geologic literature. The definition may be paraphrased as: *"A cave is a natural underground open space, consisting of a room or a series of rooms and passages, generally with a connection to the surface and large enough for a person to enter."* Note that there is no specific requirement on the type of host rock, or on the size of the cave.

The **Academic Definition of cave** is proposed here as follows: A cave is a natural opening in the ground, in any geologic material, large enough to accommodate a human being, such that the person is totally roofed by the cave and would not be hit by a vertically falling rain. This all-inclusive definition may also be called the **"Dripline" Definition** of a cave. It includes even the smallest of such openings. It is totally unbiased, without regard to size, age, type of parent rock, geographic location, or mode of origin of the cave. Therefore this can be considered the **"Equal-Opportunity" Definition** of a cave.

Two parenthetical notes may be made regarding these definitions. First, there are numerous examples of pits, either karstic or pseudokarstic, that do not have driplines and are merely vertically walled shafts extending down from the surface. A case-by-case consideration would be needed in order to determine if these features are caves based on their depth. This certainly would be subjective. For example, one may decide in order for a vertical pit from the surface to qualify as a cave, it must be deeper than a person standing vertically at its bottom, thus completely enclosing that person except for the opening above.

Secondly, it is useful to define a "dripline." Consider vertically falling rain in the vicinity of a cave opening or overhanging cliff. The rain will hit the ground surface, but will not do so inside the entrance to the cave or beneath an overhanging rock. The line that marks the edge of the falling rain, where it is prevented from hitting the ground by overlying earth materials (typically rock), is known as the dripline. The dripline is considered the beginning of the cave. Passing the dripline and thus going underground (below the earth material) is the act of entering the cave.

What is an Eclectic Cave?

An eclectic cave is one that meets one or more of the following criteria: (1) it occurs in a geographic or geologic setting not typically associated with the occurrence of caves, (2) it has a genetic history that is atypical, highly unusual, or unique, (3) it has an unusual relationship with its surroundings, and (4) it has an interesting human history.

Aspects of eclectic caves include: (1) they are generally small with respect to length, depth, and/or volume, (2) they are often found in otherwise "caveless" areas, or far afield from more common types of caves, and (3) they are classified broadly as examples of pseudokarst; however, some are truly karstic.

Eclectic caves have been largely ignored for the following reasons: (1) they are small, (2) many are not well known and published information on them is poor or nonexistent, (3) most pose little or no challenge for exploration, (4) many require excessive time and energy to find or visit and that may be perceived to be not worth the effort, (5) They are poorly understood or appreciated, and (6) they are not considered to be caves by the caver definition.

Genetic Classification of Caves

In order to appreciate the variety of eclectic caves, it might be instructive to consider a checklist of ways that caves are formed, including both karstic and pseudokarstic examples. A brief description of each is given here:

Dissolution (Solutional) Caves - Caves formed by the dissolving of rock by slightly acidic groundwater. Most or the Earth's largest, longest, most complex, and most challenging caves are of this type. They are typically formed in carbonate rock (limestone, dolostone, or marble) or in sulfate rock (gypsum). They may be formed in relatively insoluble rock (granite, quartzite, etc.) These are true **karstic caves**. The remaining types that follow are pseudokarstic.

Volcanic Caves – Caves formed in rapidly moving (low-viscosity) lava flowing downhill from a volcano. The outer surface of lava cools and solidifies and the molten inner part continues to flow after eruption ceases, leaving behind a tube or tunnel (**lava tube**). Some may by of considerable length (up to tens of miles long), but most are much shorter. On occasion a small cave may be left behind as a mold of a biological organism (tree or animal, for example) that has been overrun by a lava flow and subsequently the remains have decayed, leaving a void. Volcanic caves are typically formed in basalt or diabase.

Littoral (Sea) Caves – Caves formed by the continuous, unrelenting crashing and abrasion of waves on a rocky coastline of an ocean, sea, or lake. They range in size from mere pockets to large openings up to a few hundred feet high or wide. They can be formed in any type of bedrock along a coastline.

Eolian (Wind) Caves – Caves formed by "sandblasting" as wind blows silt or sand against a rock cliff or steep slope. Like littoral caves, these vary in size from pockets to moderately large chambers. They seldom consist of more than a singular chamber. They form best in sandstone in arid regions. A vary of these openings are alveoli or tafoni that are found in environments that have harsh winds perhaps in association with humid air or cold, dry air.

Glacial (Ablation) Caves - Caves formed in ice by water or wind moving down slope at the base of a glacier. They consist of main passages and tributaries and may extend for thousands of feet into a glacier. Because glacial ice is continually on the move, these caves are ephemeral and are continuously being modified or destroyed. They are formed in ice, the solid state of water. Some glacial caves are deep crevasses in glaciers or interstices among jumbled ice blocks at the toe of a glacier (similar to talus caves, described below).

Suffosion (Piping) Caves - Caves formed whereby groundwater plucks small grains in a sedimentary deposit within a hillside, in a process that may be viewed as underground gullying. The process is largely mechanical and erosional in nature. Although some suffosion caves may reach several hundred feet in length, most are considerably shorter. They generally consist of a solitary passage, but they may have a branching, network pattern with tributaries. They form best in unconsolidated or loosely consolidated rocks of mixed sand and clay composition or in cases where an overlying deposit may be indurated or case hardened and less subject to collapse.

Hydroerosional (Undercut or Fluvial) Caves - Caves formed by streams that cut laterally into their banks, forming an undercut opening extending back far enough to permit human entry. This is an erosional process by running water. In rare instances, flowing glacial ice (solidified water) may create undercuts and thus caves formed in this way may be included in this category. Hydroerosional caves are usually formed in unconsolidated sediments; however, with long-term abrasion, caves may also form in consolidated bedrock.

Hydrothermal Caves – Caves formed by superheated water coming to the surface. Some openings of former geysers or geothermal springs may be enterable. They may be of any orientation, horizontal or vertical (pits). Additionally, deposits of travertine produced through precipitation from hot water often form voids as the material is deposited. If large enough to enter, they are caves. Most of these caves occur in calcareous rock such as travertine or tufa.

Fracture (Tectonic, Fissure, or Rift) Caves – Caves formed by separation of bedrock, owing to shifts in crustal rocks, such that an individual is able to get underground. Where rocks are split widely enough to allow entry. Separation of blocks may be produced by rifting as the result of tectonic activity or mass wasting, such as block gliding. Freeze-and-thaw cycles involving water in fractures may also contribute to rifting. Caves of this type consist of a fissure that is roofed over. The roof may consist of geometric ledges in the fractures or by blocks that have slid or fallen over the fissure, providing a dripline for the cave. There is some overlap in nature of these caves and those of the next two categories, rock city caves and depositional caves. Fracture caves may occur in any type of rock.

Rock City Caves – Caves formed by the separation of bedrock into a series blocks. The process involved is one of mass wasting known as block gliding. Blocks separated by fractures slide on a moderate slope, usually on another bed of rock beneath. The glided blocks form avenues among them, usually along several directions, giving the appearance of a city structure with streets (the avenues of separation) and building (the blocks); hence the name "rock city." Caves are formed if some of the avenues become roofed over (in whole or part) forming driplines. The roofs may consist of other glided blocks or talus that has fallen into the avenues. In some cases the sides of the blocks may be jagged or angular and cause overlaps or some blocks may begin to topple and lean against one another thus roofing the voids. Rock city caves may occur in any type of rock.

Depositional (Talus or Rockfall) Caves – Caves formed as openings beneath or among rocks that have fallen or toppled from a cliff or have slid or rolled down a slope, forming a jumble or pile where they come to rest. This accumulation is known as talus. The chambers formed in this way are typically no larger that the boulders that surround them. There is a wide range in length of these caves. A cave may exist under a single boulder propped on top of other rocks and perhaps have a dripline completely around the boulder and thus have no walls. Other talus caves consist of accumulations of hundreds of boulders whereby a large number of cavities may be negotiated in succession by an explorer. Caves in excess of one or two miles in accumulated length have been documented in northern New England, for example. These caves can form in any type of rock that is subject to be broken into large enough talus blocks to form cavities with driplines.

Depositional caves may also include openings that are formed in the deposition of sediments. Openings forming concomitantly with deposition are known as primary porosity. It is rare to have pores formed that are large enough to accommodate a person. The most common cave of this type is one formed by precipitation of travertine on the Earth's surface by running water at surface temperatures.

Undercutting (Shelter, Overhang) Caves – Caves formed by a rock ledge that protrudes horizontally from its base or from rocks underneath. They usually consist of a single chamber open at on or more sides and range in size from small pockets in cliffs to high and wide, overhanging cliffs. Rock under the ledge may have spalled in response to gravitational mass wasting or to frost activity. They can form in any type of rock.

Organically Produced (Biological) Caves – Caves formed largely by the active or passive presence of animals, plants, or in rare cases, lesser organisms. There are examples of openings hollowed out by animals licking sediments that contain salts to an extent that the openings become large enough to admit a human being. Elephants have licked out caves in Africa and smaller animals have similarly created some caves in Mississippi. Openings left as molds of trees or animals in lava flows (such as those found in lava terranes in the Pacific Northwest) are thus organically produced caves, even though they may also fall into the category of volcanic caves (above). Many types of rock may host organically produced caves.

A disclaimer is in order at this juncture. Organic or biologic processes, although all are chemical or physical to various degrees, are still natural. A philosophical argument can be made that all activities by human beings (who are, of course, naturally occurring organisms) are natural events. It would logically follow then, that any humanly produced underground opening in natural earth materials that is large enough for a person to enter beyond the dripline would qualify as a cave. This would include all subsurface excavations including tunnels, mines, root cellars, hollows for habitation, and others. Even though these features may be called caves in the literature (for example the Caves of Ajanta in India or the homes carved from tuff in Capadocia in Turkey, just to name two), they are not considered to be caves by persons who are geologists, cavers, or cave scientists. It is prudent to eliminate anthropogenic subterranean openings as caves, as well as other karst-like features formed by human activity (for example, sinkholes over mines or induced by pipelines) when addressing conservation and management of karst and pseudokarstic.

Uses of Caves by Mankind

People have entered caves from the beginning of humankind. Curiosity may have been the motivation for them to venture underground. However, caves have been used for a multitude of purposes by primitive peoples and by individuals in the more modern world. A compilation of activity associated with caves is presented here. Most of these uses involve small caves and in many instances the unusual circumstances under which caves are used are indeed eclectic.

Habitation - Caves have been used as dwellings from the beginning of modern mankind. Not all types of caves are conducive for living, even by the most primitive people. For example, solution caves are generally too damp for year-round shelter, but humans may have frequented them. Evidence of intermittent use includes early cave paintings, pictographs, petroglyphs, and other archeological and historical materials that are commonly found in them. Occupied caves occur in virtually all types of rock.

Prehistoric habitation of caves - Modern man and his ancestors (for example, Neanderthal man) commonly lived in the entrance areas of caves where the primary need was a roof overhead. In this situation caves, including the entrances of some very long solution caves, merely served as shelters. Some shelters were large enough to house entire communities such as villages and tribes. Others, much smaller, may have only housed a family or two. Occupation of some caves in Europe, Africa, and Asia dates back to prior to 25,000 years ago. However, in North America occupation of caves extends back only as long ago as the established peopling of the continent by migration from Asia (12,000–13,000 years ago).

Native American habitation of caves - Indians have used caves as shelters throughout North America. Many have merely camped in the overhanging entrances to large caves or in shelters of various sizes. Others have built adobe buildings within large shelters. The most elaborate cliff dwellings, such as those built by the Anasazi people, are found in many places in the southwestern United States. Many of the finest examples are preserved within the U.S. National Park System (for example, Mesa Verde National Park in Colorado).

Modern habitation of caves - Few people in modern times have lived in caves. Most of those who did were hermits, troglodytes, or anchorites. Several cave hermits are now celebrated folk figures. For example, the Leatherman wandered from cave to cave, making a 34-day circuit through New York and Connecticut in the late 1800s Additionally, woodsmen and pioneers used caves as temporary shelters for protection against the elements or as hideouts during encounters with an enemy. The legendary Daniel Boone used some caves during his treks into the wilderness.

Mining of cave deposits - In some large caves formed by dissolution, modern man has mined minerals from sedimentary deposits within the caves. These include:

Saltpetre (potassium nitrate) - Saltpetre is found within the silt and clay on the floors of many caves, in particular those that have dry sections. Saltpetre was leached from the cave dirt and mixed with sulfur and charcoal in order to produce gunpowder. This source of gunpowder was crucial in the American Revolution, the War of 1812, and the Civil War. Well-preserved examples of saltpetre-mining operations can be viewed in Mammoth Cave National Park and other caves in Kentucky and in caves of Virginia, West Virginia, Tennessee, Alabama, and Georgia.

Bat Guano - Significant accumulations of fecal droppings from bats have been mined as a source of rich fertilizer. This has been done over the years in Carlsbad Caverns National Park in New Mexico and Frio, Ney, and Bracken Bat Caves in Texas, among others.

Phosphates - Potassium phosphate has been mined and leached from cave dirt as a source of fertilizer. This is still being done at several isolated caves in Mexico, for example, despite the modern manufacture or artificial fertilizers.

Sulfates - Some Native Americans mined gypsum, mirabilite, and other sulfate deposits from caves of the central lowlands (for example in the caves of central Kentucky or southern Indiana). Scraped from walls and ceilings of passages, these minerals were used in various ways, including paints and medicines.

Caves of war - Historical records indicate that there were times during battle when caves were used as natural protection, strategic fortification, or as refuge from attacks or raids. One well-known example is the snipers' outpost, known as Devils Den, on the Gettysburg Civil War battlefield in Pennsylvania. Another is a series of caves among jumbled blocks of lava in Lava Beds National Monument in northern California used as protection during the Modoc Indian Wars.

Tourism (show caves) - Today, perhaps the most visible use of caves is as tourist attractions. Show (also known as commercial) caves are found in many states. Most are dissolutional caves in limestone, but some have formed in marble, gypsum, lava flows, sea cliffs, and talus. It is on tours through these developed show caves that most people first experience caves and learn about them. Many show caves are units of national and state park systems. Some notable national park caves are Mammoth Cave in Kentucky, Carlsbad Caverns in New Mexico, Wind and Jewel caves in South Dakota, Timpanogos Cave in Utah, Lehman Cave in Nevada, and Russell Cave in Alabama. Some caves in the United States were operated as attractions in the early to middle of the nineteenth century, including Fountain and Weirs caves (now Grand Caverns) in Virginia, Wyandotte Cave in Indiana, and Howes Cave in New York.

Entertainment - From time to time caves have been used for shows or live entertainment. There are several caves that had ballrooms or theaters, complete with wooden floors and seating, and dances with live music were held in the coolness of the cave during the hot summer months. Examples include Greenville Saltpetre Cave and Kenny Simmons Cave in West Virginia. Caves have also served as settings for motion pictures and plays.

Illegal enterprises and hideouts - Throughout modern history criminals and others breaking the law have used caves as refuges and hideouts. These are some of those uses:

Moonshining - Perhaps one of the most common illicit operations in caves is the distillation of bootleg whiskey. Stills have been discovered in many backwoods caves. On occasion these operations are found to this day.

Counterfeiting - Caves have been used as hideouts by counterfeiters. This is true of some small caves in the early settlements in New England.

Bandits - Bandits, highwaymen, and other outlaws have used caves as hideouts from the law. Celebrated fugitives reportedly using caves include Jesse and Frank James in caves of Missouri, Sam Bass (the Ohio River Pirate) at Cave-In-Rock, Illinois, and others.

Drug production – There have been a few modern instances where illicit production of drugs has been discovered in caves, including growing of marijuana with the aid of electric lightning.

Protection - Caves have been used as refuge from natural and man-made disasters or from inclement weather. Some people hid out in caves during Indian raids. Others braved the elements inside caves, protected from harsh blizzards and cold weather. In more recent times, such as the onset of the cold war in the 1950s and 1960s, many caves were designated as shelters against radioactive fallout from potential nuclear bomb attack. The federal government stocked some caves with bottled water and emergency food rations.

Religious sites – Some caves have served as sacred places. Archaeological evidence has supported this. Even today, this use is found at some localities (for example at the Grotto of Lourdes in France). Caves have also been used as places of worship for both primitive and modern cultures alike.

Burial sites - Although not practiced any more, burial of human remains has occurred within some caves. These are primarily Native American burials and are associated with artifacts at the site. These sites are protected by state antiquities acts and looting is outlawed.

Cold storage - As natural openings, caves were used from time to time for cold storage of perishable food in much the same way as were root cellars that were artificially dug in the ground.

Sources of water - Many cave entrances are springs, providing natural and often irreplaceable sources of water. This use of caves may be the most important and valuable. Unfortunately, clean spring water is only attainable if the recharge zones feeding water to the springs are protected from contamination.

Receptacles for refuse - Far too many caves have been used as holes for the disposal of trash and waste produced by industry, agriculture, or individual home dumping. Many caves open at the bottoms of sinkholes that were (or are) sites for dumping. Today, contamination of groundwater is a major environmental problem in karst and pseudokarst regions.

Conservation and Management Issues

As one can see from the foregoing, there is a great deal of variety in caves, especially when the pseudokarstic caves are included. Moreover, historic use of caves is highly diverse. Many of the small caves are the most eclectic, with aspects that are highly unusual or unique. Attributes of caves give them values. Caves have scientific value, historic value, archeological value, and biological value. Values are not necessarily correlative with the size of a cave.

Historically, conservation and management of cave and karst resources are relatively new pursuits that began in earnest only a few decades ago in response to increasing environmental stresses from human activity. Impetus for conservation and management has been enhanced in recent years by a growing understanding of karst processes. There is now a greater understanding of how these processes work, how sensitive karst is to changes on the land surface, and how fragile cave environments are, including delicate formations and organisms that are found in them.

The preceding listings of types of caves and how they have been used serve to illustrate the diversity and significance of smaller and "non-traditional" caves. If the speleological community and others wish to protect karst areas and caves from environmental damage or destruction, it stands to reason that small and eclectic caves should be included along with the large and more visible examples.

Small and unusual caves are often located in highly populated areas and are thereby frequented by the local population. Children often visit these caves for play or curiosity. Many small caves have been environmentally stressed. Graffiti painted on walls and excavation and removal of materials from them are common problems. Moreover, in some places, lesser caves may be obliterated during construction projects.

The best means of protection of small and eclectic caves is through stewardship and education. Management of these features presents unique challenges, as there is often a lack of local interest in preserving them. However, if their significance is demonstrated through educational and outreach activities, local stewardship may result. A small cave that has an interesting history or that serves as a natural curiosity may be visited often. Educational materials, such as brochures, booklets, video productions, and articles in local newspapers and magazines that highlight interesting stories behind these caves may provide an effective means of conserving those that have locations that are already well known and those that are already well visited. Of course, as is the case with many large caves, it may be best to keep locations of certain sensitive small and eclectic caves secret and to publish little or no information about them. This is always a case-by-case decision.

Premises to Consider in the Protection of Small and Eclectic Caves

A series of premises can serve to remind us to not exclude nor ignore the so-called "lesser" caves. The following is a list of seven concepts to consider in the conservation and management of small and eclectic caves:

- Caves form in all types of tock and in all geologic and geographic settings.
- Small caves are often the only caves found in non-traditional regions that are often regarded as "caveless."
- Small and eclectic caves may have been formed by unusual and interesting geological processes or may occur in atypical host rocks.
- In many cases, small caves have more interesting human histories than do larger caves. Some are important archeological sites.
- Small and eclectic caves may be just as sensitive, fragile, delicate, and vulnerable as are their larger counterparts.
- All caves begin as small caves. Geologically caves evolve with time and most begin small and increase with size during their genesis. This is particularly true of dissolutional caves. When caves are first explored they are small and become more extensive with continual exploration and discovery of new passages and/or chambers.
- There are no insignificant caves. However, there is a continuum of significance, with some caves being more significant or important than others.

Conclusions and Recommendations

To summarize, nearly every cave has significance and is of academic interest. It may have formed in an unusual manner or in a unique geologic or geographic setting. The more interesting and significant the cave is, the greater will be the need for its protection. Many caves, large and small, are environmentally stressed. Conservation and management strategies and practices have evolved over the last few decades. Small caves have often been overlooked. Their importance is amplified if they are the only caves in a region and are not distributed among larger more visible and recognized caves.

It has been a common practice in the compilations of cave surveys and inventories, especially those compiled by cavers on a statewide or countywide basis,

Cavers and speleologists have been compiling surveys and inventories on a statewide or countywide basis for some time. In regions that have many large caves, small caves have received little or no attention. It has been a common practice to designate small caves as "For the Record Only," abbreviated as FRO, and include them with little in the way of description and without a drawing or map. Many are not given a name and listed only as "FRO." In closing, as an appeal, it is suggested that every cave should get the attention it warrants and that the For the Record Only designation be eliminated.

Acknowledgements

I thank the many cavers who share my pleasure in searching for small caves, both in the field and in the literature, and who have a fascination with eclectic caves, with pseudokarst, and with spelean history. Many cavers have contributed to my understanding and knowledge of small and eclectic caves, including the late Robert W. Carroll, Jr., Steve Stokowski, William R. Halliday, Chuck Porter, and Cato Holler. Karen M. Kastning and our son, Kass, have accompanied me in the field when visiting and documenting many small, out-of-the-way caves in many parts of our country.