UNTOLD SECRETS of Planet Earth

CATASTROPHIC Caves

Vance Nelson

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Dedication

This book is dedicated to Dr. Gary and Mrs. Mary Parker. They have been an inspiration to me since I rejected evolutionary ideas, received Christ, and turned to His truth in Scripture. They have always shone the light of the Saviour Jesus Christ, and encouraged me to carry on with my research and writing. Without their constant encouragement over the years, it would have been tougher to fight the good fight.

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Mexican cavern with underground river

Preface

Standing huddled together in a group, somewhat impatiently awaiting the guide: for most people, this is the beginning of a cave tour. Then, this is often followed by the pre-tour instructions. These are usually filled with warnings—some common sense but, some for the sake of preserving the caves. I remember listening to such warnings when I was on a cave tour at a fairly young age. One particular statement went something like this: "Do not touch the stalactites because, if you happen to break one off, it will take thousands of years, perhaps hundreds of thousands of years, for it to grow back."

Since becoming a Christian at age nineteen, I have contemplated a number of the things I heard on cave tours such as: "It takes a thousand years for a stalactite to grow one centimetre." If this is true, and I have personally seen stalactites nearly two metres (six and a half feet) long, then some of these formations would have taken two hundred thousand years or more to grow.[1] This would seem to lend credence to the idea of vast ages, and away from Biblical history. This apparent discrepancy forced me to begin to study this issue intensely starting in about 2004.

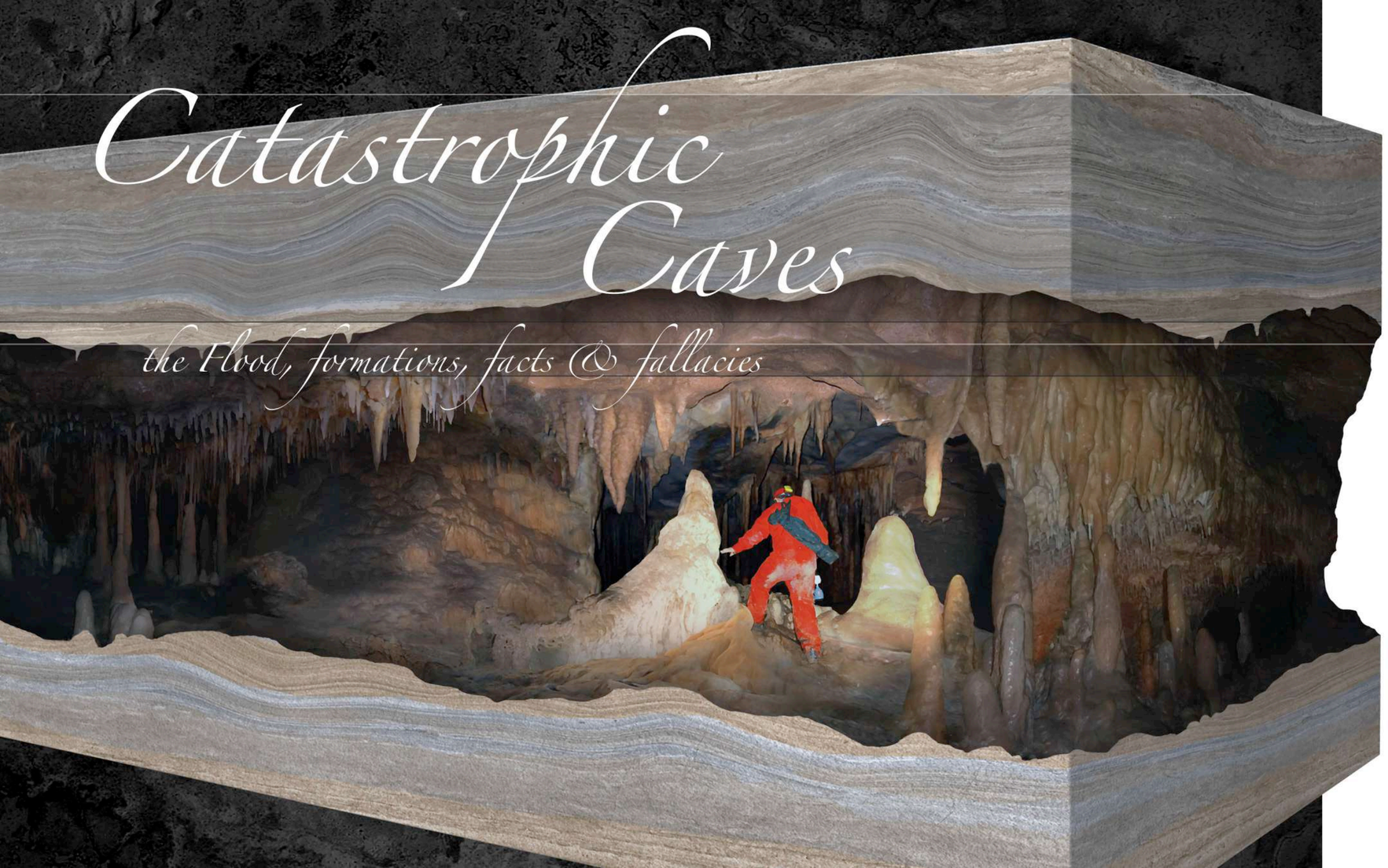
Does it take a lot of *time* to form stalactites, stalagmites, and other cave formations? Remarkably, as I discovered, *time* alone has very little to do with it. It has to do with conditions: the drip or flow rate in combination with the saturation of the solution, along with other factors.

It is my hope that after you have examined the evidence in this book, which I have painstakingly gathered from around the planet, you will consider cave formations in a new light. Perhaps you will re-think the long-age story. I once accepted the old-Earth view without hesitation. Now, after years of investigation, I can no longer accept it as a fact.

Take a look at the evidence. You will see many untold secrets of planet Earth. I have reserved many specific examples for this book. There are, however, a few examples which have been well known, and well circulated. I have included them, because they are such exquisite illustrations of how quickly calcite, and other forms of calcium carbonate, can form into cave formations.

The next time you are huddled in a group, awaiting a guide for a cave tour, you may have a different perspective. Perhaps you will hear some of the same statements that are being made around the world on such tours, for example, "It takes a thousand years for a stalactite to grow one centimetre." Perhaps, you may want to question that statement after reading this book and seeing the evidence contained within it.

It is my deepest hope that my travels, research, and photographic documentation will be a help to you. It is also my prayer that this research will help persuade you that Biblical history can be trusted. It is upon this foundational history that we understand there is hope in the Son of God, Jesus Christ, who alone can forgive sins and give eternal life.



Catastrophic Caves

the Flood, formations, facts & fallacies

Introduction

Quiet droplets of water could be heard in the background. The candle-like illumination faintly lit the rocks on either side of us. I could feel an ever-so-faint breeze on the back of my neck. I stood near the entrance of the cavern system with a dozen others listening to the guide. His first question was, "Are there any geologists with us today?" I never mentioned my interest nor my experience in the area. He was relieved that he wouldn't get challenged today. He proceeded to tell us that these limestone rocks were deposited on the bottom of the sea over three hundred million years ago. Then his flashlight turned on, and shone onto the wall. The proof of the three hundred million plus years? There it was: crinoid fossils. There was no doubt about their being crinoids, but were the layers this cave was carved from laid down hundreds of millions of years ago? No one seemed to question it.

Then, showing us a stalactite hanging from the ceiling, he said, "It takes one thousand years for a stalactite to grow one centimetre." Science, however, gives a very different scenario. The drip rate, the saturation of the solution, the temperature of the solution and surrounding air, the carbon dioxide concentration in the air, and other factors all affect how quickly, or slowly, a stalactite will grow.[2] The simplistic formula for stalactite growth—one thousand years equals one centimetre—repeated incessantly on public cave tours, is simply not scientific.

Tour after tour begins with "millions of years." Caves are used as an indoctrination mechanism for old-Earth advocates. But, do caverns actually show evidence of being formed slowly and gradually over vast periods of time? The evidence in this book may change your whole way of thinking about caverns and the formations found within them.

Cave or Cavern?

A cave is a chamber in the ground or rock, which is substantial enough so at least some portion of it does not receive direct sunlight. A cave does not have to be in rock which is soluble. However, most of what we will be investigating in this book will fall under the more descriptive definition of caverns. Caverns are caves which are found in soluble rocks, such as limestone, dolomite, marble, and gypsum.[3,4] Since caverns are found in soluble rock, they often grow beautiful formations through the deposition of minerals carried by water. These formations are known as speleothems. These definitions are very basic, but hopefully helpful in understanding the difference between a cave and a cavern. Most of the "show caves" people take tours of, which have beautiful formations within them, are more descriptively known as caverns.

One thing is for sure, exploring caverns, the activity known as spelunking, can be great fun. One is often struck with awe as the lights shimmer off the crystal-like structures, as if they were diamonds. As one ventures to the "other-worldly" depths below the surface of the earth, it is like entering another realm, one of extraordinary beauty. There is a peacefulness about being within these caverns.

Nevertheless, spelunking can also be an adventure which sheds light on the true history of planet Earth, a history which is not typically shared by the guides on public cavern tours. Let us see what we can glean from the evidence around the world related to caverns and the formations within them.

Can the Rocks be Millions of Years Old?

Can the rocks from which these caverns are carved really be hundreds of millions of years old? That is a great question, and one for which we have some good scientific evidence. If fossils in the Earth's crust have not been replaced with minerals, they can be dated with radiocarbon dating. This has been done using secular labs.

Many of the early founding fathers of geology and palaeontology believed that most rocks, and the fossils they contained, were laid down only a few thousand years ago during Noah's Flood.[5] Can this be tested? Yes, it can.

Fossils from the bottom of the geologic column, such as those in the Cambrian deposits, up through Permian deposits, Jurassic deposits, Cretaceous deposits, etc. have been subjected to carbon-14 analysis.[6] Carbon-14 offers a great way to test two competing views on the age of things: old-Earth vs. young-Earth. If these fossils, and thus the rocks, really were millions of years old, then no original radiocarbon should be detected. However, if these fossils were laid down during Noah's Flood, just thousands of years ago, there should be detectable radiocarbon. The results demonstrate that the fossils, and thus the rocks they have been found in, are only thousands of years old. Detectable radiocarbon has been found in fossils throughout the geologic column.

Based on the radiocarbon dates, the fossils, and thus the layers, were laid down at approximately the same time. This means that both evolution and old-Earthism are dead.

If you think about the creatures themselves, it means the creatures lived and died at the same time, in the same event, only thousands of years ago. The founding fathers of geology and palaeontology, most of whom believed in Noah's Flood, are finally being vindicated by science.

Furthermore, we now have scientific evidence that none of the layers from which caverns have been carved are hundreds of millions of years old. They are only thousands of years old. How do you get thousands of feet of sediment, burying billions of creatures in one event, recently? Noah's Flood would do it.[7]

Therefore, cavern formation has clearly taken place recently. Since cavern formations must form *after* caverns develop, they must be *younger* than the caverns themselves. Cavern formations, therefore, cannot be hundreds of thousands of years old.

Exhibition Chamber, Lucas Cave (Jenolan Caves, Australia)

Biblical History: When did Most Caverns Form?

We've all heard how slowly caverns form. It takes thousands of years or more for this to happen, doesn't it? Read carefully as National Geographic explains the process:

> The acidic water percolates down into the Earth through cracks and fractures and creates a network of passages like an underground plumbing system. The passages widen as more water seeps down, allowing even more water to flow through them. Eventually, some of the passages become large enough to earn the distinction of "cave". Most of these solutional caves require more than 100,000 years to widen large enough to hold a human.[8]

So, what does one say to this? As with all old-Earth scenarios, National Geographic assumes a number of specific conditions when they come up with these vast periods of time for the formation of caverns. First of all, they assume that caverns formed by the processes we see operating today. This is known as uniformitarianism. To put it another way, they assume there never was a worldwide Flood, which could have created vastly different water flow conditions in the past. Secondly, they assume that the acid solution carving the caverns resulted from rain water coming down from the surface. The problem, however, is that as acidic water comes from the surface and interacts with the limestone, it loses its acidity. That is, it loses its ability to carve caverns. It has been shown that after about 10 m (32.8 ft) of flow into cracks in the limestone (downward), carbonic acid is neutralized.[9]

National Geographic is assuming that the acid would be a very weak acid, such as carbonic acid, common in soft drinks. Carving a cavern, especially a deep cavern, would take longer with a weak acid such as carbonic acid. In fact, as pointed out above, it likely wouldn't happen at all. When it comes to carving a cavern, two things are true: 1) a strong acidic solution, such as sulphuric acid is needed and 2) the acidic solution doesn't need to come from the surface down.

What is typical of most caverns is that they show evidence of having been formed by the inundation of acidic water.[10] Furthermore, it is now being admitted by speleologists that there are indeed caverns which have been carved by sulphuric acid, and not by carbonic acid.[11] In fact, carbonic acid is likely not the main solution by which most caverns have been carved. Interestingly, the final part of the process in creating these caverns could have taken place immediately after Noah's Flood. Dr. Steven A. Austin explains:

> After the flood waters had completely receded, the regional groundwater level would be in disequilibrium and horizontal flow would be significant. Acids from organic decomposition at the surface and at depth would tend to move to just below the water table where the highest horizontal velocities of flow would exist. Solution of newly consolidated limestone would occur chiefly in horizontal conduits at a level just below the water table. The mixing of vadose water (CO_2 rich, oxygen rich, organic poor, and low salinity) with phreatic water (CO_2 poor, oxygen poor, organic rich, and high salinity) would also produce conditions ideal for solution of limestone near the water table. As a result, a cave system would be developed at a certain level.[12]

First (**Fig. 1**), all the layers of limestone (as well as dolomite, gypsum, etc.) were laid down during Noah's Flood. Second, shortly after this phase, *many* of these sediments would have begun to lithify, turning them into solid rock. Third (**Fig. 2**), as these layers were uplifted (with respect to the ocean basins), some of the layers would have cracked, twisted, and compacted (Psalm 104:6-9) during the end of the Flood. Highly acidic water entered the cracks and joints. This could have begun the cavern carving process.[13] Fourth (**Fig. 3**), directly after the Flood, the groundwater level would not be in balance, and therefore the horizontal flow within the layers of sediment would be appreciable. This mainly horizontal flow, which would be highly acidic as explained above by Dr. Steven A. Austin, would continue to rapidly dissolve the limestone (dolomite, gypsum, etc.) along mainly horizontal joints. Thus, it is possible that cavern formation began before the Flood ended, and fundamentally ceased a few years after the Flood concluded.[14] Fifth (**Fig. 4**), when surplus groundwater had been drained away, after the caverns had been carved out, they would be filled with air, rather than with acidic water. After a short period of time, when downward drainage from the surface began, speleothems could quickly develop under the right conditions.[15]

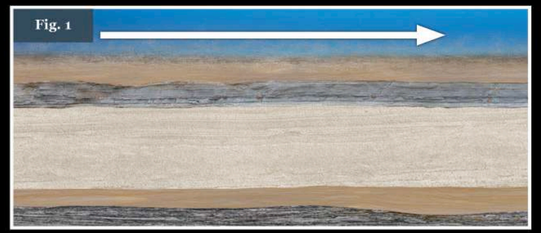
This is one model which explains what we observe in most caverns (and aligns with Biblical history).[16,17,18] Caverns could have formed rapidly, as a result of the global Flood in the days of Noah, which occurred about 4,400 years ago.

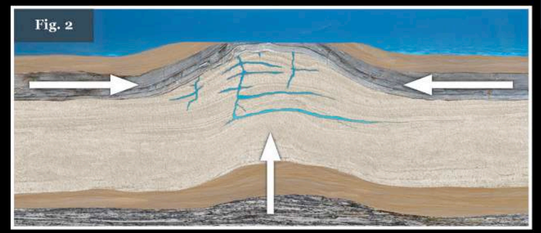
When the evidence is evaluated through the lens of Biblical history, it seems clear that the carving of most caverns could have occurred at only a few possible stages in Earth's history. Furthermore, there are some stages of Biblical history at which caverns could not have been carved. For example, this could not have occurred pre-Flood, since the fossil-bearing sedimentary layers would not have existed prior to the Flood of Noah.

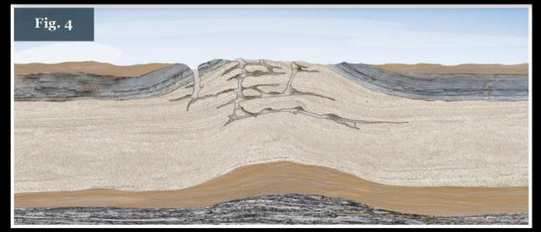
It must not be forgotten that there also would have been residual reservoirs of water still existing on the earth after the Flood. This water could have contributed to cavern carving in certain cases. For instance, there are some caverns which have been carved, or at least enlarged, by mechanical means via underground rivers. Further to this, the weather on the earth directly after the Flood would have been warmer, more humid, and conducive to greater rainfall at many locations.

After some time in favourable areas, there was an Ice Event, typically called the Ice Age. This Ice Age would have followed the Flood, and peaked roughly half a millennium after the close of the Flood.[19,20] The ice would have then started to melt back for a few centuries after that time period to roughly today's levels.

It seems clear, when looking at cavern formation using Biblical history, that conditions would have been most conducive for the development of caverns during and directly after the Flood. However, the formation of caverns today would be a very rare event.[21]





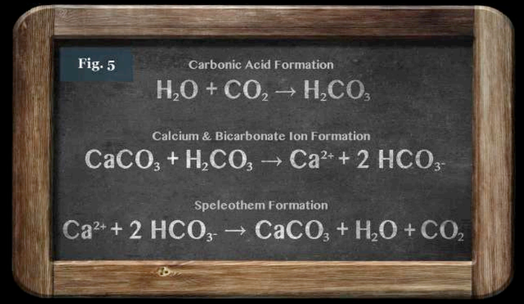


How do Cavern Formations Develop?

Cavern formations, or technically speleothems, are secondary mineral deposits in caverns which have been deposited by dripping or flowing water, rich in minerals. At least three hundred and nineteen different kinds of mineral deposits are known from caverns.[22]

What is the chemistry behind the development of cavern formations? It's actually quite simple. It starts with the dissolving of the rocks, generally limestone (but sometimes marble or dolomite).

As rain water falls and picks up carbon dioxide from the soil and/or air, it forms a weak carbonic acid solution which then seeps into the limestone (or marble) rocks below. As the carbonic acid solution flows through the cracks in the rocks, it dissolves calcium carbonate which then goes into solution as calcium ions along with bicarbonate ions. When the solution containing the calcium and bicarbonate ions reaches the inner surface of the cavern, carbon dioxide is released (degassing) and calcium carbonate is precipitated as stalactites, stalagmites, flowstone, etc. This doesn't necessarily happen instantaneously; it happens as the water drips or flows into the cavern. Calcium carbonate can be precipitated in several different crystal forms. The most typical crystal form is calcite. It can also precipitate in the crystal form known as aragonite. The series of formulas for the development of formations in caverns can be seen in Fig. 5.



Biblical History: When did Most Cavern Formations Develop?

What is needed to form speleothems, the formations within the caverns, is lots of water carrying calcium bicarbonate in solution. As already touched on, based on climate models, the early post-Flood climate would have been warmer, wetter, and thus more humid in many areas of the Earth than what we currently experience today. These are precisely the conditions necessary to produce the quantity of water required for excessive water flow through the rock layers and into the freshly carved cavern systems. This tremendous flow of water would have resulted in the rapid deposition of massive amounts of calcite and aragonite within the cavern systems around the world. How long would it have taken to get large deposits, such as seen in Carlsbad Caverns (Fig. 6)? Since it's not dependent on time but the rate of deposition, even the largest cavern formations could have easily formed within hundreds of years. As previously emphasized, water flow combined with the amount of calcium bicarbonate in solution are the two most important factors which result in the deposition of calcite.[23]

As already discussed, roughly half a millennium after the Flood, the world experienced the peak of the Ice Age. These ice sheets would have melted in the next few centuries.[24,25] The tremendous water flow drainage buildup would have resulted in speleothem development over many areas of the planet.

However, at the end of the Ice Age, climate fluctuations resulted, and eventually desertification ensued in various regions worldwide. This would have dramatically slowed down speleothem development in many areas, and eventually many cavern systems would have become essentially dead during this time, with little to no new calcite growth from that time forward.

Cavern formations from countries around the world show indications of developing rapidly during the abundance of water flow, and sitting relatively dormant in the near absence of water since then.

Fig. 6 Carlsbad Caverns, USA

Can Speleothems be Dated to Hundreds of Thousands of Years Old?

The dating of speleothems by the radioactive isotope uranium-234 to thorium-230 decay series seems an absolute method to some scientists. However, as secular speleological expert Dr. Miryam Bar-Matthews from the Geological Survey of Israel points out, there are problems with the underlying assumptions.[26] Though she does not dismiss the method, being a secular "believer" in the vast eons of time, she inadvertently points out several problems which could be serious for the method. She does so based on what is known, not what is unknown.

First of all, she points out that the radioactive isotope uranium-234 is soluble in water, and as such incorporates itself into the calcite lattice. Therefore, it should not be a surprise to find it in cavern formations. However, thorium isotopes are insoluble in water and are found incorporated into clays and iron oxide minerals. In other words, any thorium isotopes found within the calcite should be the result of the radioactive decay of uranium-234. These are the first two assumptions that underlie the dating of speleothems: that radioactive uranium-234 is *originally* found within the calcite, but thorium isotopes should not *originally* be found within the calcite. Any thorium isotopes subsequently measured within the calcite are therefore *assumed* to have been generated from the decay of uranium-234.

Secondly, if thorium isotopes were *actually* incorporated into the calcite lattice when it was *originally* formed, this creates a major problem with the second foundational assumption which underlies the dating of speleothems using this method. Dr. Miryam Bar-Matthews states this: "In many, many speleothems, we do have thorium incorporated, with some detrital material. When we do dating, we have to take this into account, and to correct for the contribution of thorium, [assuming] that it's not associated with the decay of uranium-234."[27]

Along with other experts,[28,29] Bar-Matthews admits that thorium isotopes do in fact incorporate into the *original* calcite lattice and are found in "many, many speleothems…."[30] Can the source of the thorium isotopes always be known with one hundred percent certainty? Is the detrital source of the thorium isotopes always tested for and recognized? The claim is that this detrital contribution of thorium needs to be "corrected."[31,32] Is this correction successful one hundred percent of the time? Baker and Fairchild, experts on caverns, say this: "Although this can be corrected, it is not always known which $^{230}Th/^{232}Th$ ratio to use for correction and so errors can be much larger and the data can display age-reversals."[33] In other words, the "correction" method can lead to great errors, so much so that the final dates which result may not agree with previous dates and/or preconceptions held to by old-Earth scientists.

There are further assumptions that underlie the uranium-234 to thorium-230 method which we haven't even discussed. I would suggest that scientists, with a respect for God's Word, begin to look for other ways to date speleothems within cavern systems. One thing is for certain: the rest of the evidence in this book will demonstrate that cavern formations do not require vast periods of time to form.

What are the Various Types of Cavern Formations?

Within caverns, there are a vast array of different types and shapes of structures which can form from the minerals which come out of solution by the dripping or running of mineral water.

First of all, we'll consider what are known as "dripstones." Typical formations are those which hang down from the ceiling, known as **stalactites** (**Fig. 7**). When the water drips or runs off of the stalactites, it will form **stalagmites** on the floor of the cavern (**Fig. 8**). If they join together, they will form a **column** (**Fig. 9**).

Secondly, we will touch on "seepstones and erratics." There is cavern **popcorn**, sometimes known as coralloids, clusterites, or globulites (**Fig. 10**). It is created as water seeps out creating layers of growth in small sphere-like shapes. And finally there are **helictites** (**Fig. 11**). These are small worm-like formations, the development of which has been long debated. However, recent research suggests that their multi-directional growth may in fact be due to bacteria.[34]

The third category of formations is "pool formations." These are typically found forming (or have previously formed) around the edge of pools. **Rimstone** forms in steps like terraces and creates rimstone dams (**Fig. 12**). There is **shelfstone**. This forms only on the edge of a pool (**Fig. 13**).

Fourth, we'll consider a category known as "flowstones." There are formations known as **waterfalls** (**Fig. 14**), which appear like water has flowed over the area. Within this group of formations there are **ribbons** (**Fig. 15**). These are often formed when water runs down the ceiling of a cavern which has a bit of a slope to it. When there are slight bands of colour, tour guides will often call these formations "cave bacon."

There are various other types of cavern formations, however, this should serve as an adequate introduction to the main types of formations found within caverns.

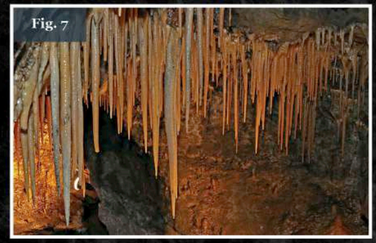


Fig. 7


Fig. 8


Fig. 9


Fig. 10


Fig. 11


Fig. 12


Fig. 13

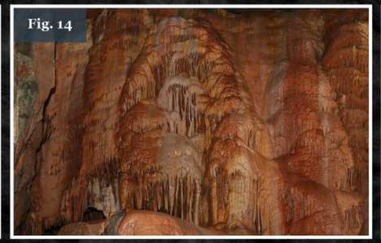


Fig. 14


Fig. 15

Did Cavern Formations Result from "One Drop of Water at a Time?"

I've spent many years researching calcite formation at mineral spring sites. One thing becomes obvious at these sites: the more water flow there is, the more quickly the calcite forms. The conditions at mineral springs versus caverns may vary slightly, such as the temperature of the water and the concentration of the ions in the water to name a few. However, at mineral springs, if the water flow is limited, so will be the growth rate of the calcite (or aragonite).

I was researching a number of the caverns at Jenolan Caves west of the Blue Mountains in New South Wales, Australia. A layman, touring with us, made an interesting comment. It typifies the general public's misunderstanding of how formations in caverns have come to be as we see them today. He said, "Imagine how long this must have taken to form, one drop at a time...." In reality, much of what we see in cavern systems simply *could not* have formed by one single drop of mineral water at a time. Here's why. Single drops of mineral water can form typical stalactites and *small narrow* stalagmites (**Fig. 16**). However, many caverns have considerably more dramatic formations, for which the processes responsible clearly required more than single drops of mineral-rich water. Here (**Fig. 17**) we can see the upper portion of a "stalagmite" which is over 15 m (50 ft) in height. It is excessively wide. In reality, it is a gigantic towering mound showing all the features indicative of large amounts of flowing mineral water in the past. It simply *could not* have formed "drop by drop."

Some caverns have massive mounds of calcite (**Fig. 18**). When we see these exact same types of formations at mineral springs, we know how they formed. For example, a similar mound of calcite is seen at Thermopolis, Wyoming, which formed in just over one hundred years from flowing, mineral-rich water (pages 82-85). At mineral springs, these types of formations typically form by lots of mineral water over a short period of time. Granted, the temperature of water plays a part as far as deposition rate. Nonetheless, the general pattern of water flow would be the same. Therefore, it starts to become evident that a number of formations within caverns are clearly the result of lots of mineral water flow over a short period of time.

The water flow has been "recorded" by the mineral deposits themselves. Wherever the water has flowed, crystals of mineral have been deposited, leaving evidence of the water's path. As we look at various formations in caverns, the shapes are indications of the past flow of the mineral water, since where the water has been, the minerals precipitate. Therefore, we have been left a "record in stone" of the water's history. Take a look at the long exposure photograph of water flowing and depositing minerals at Huai Mae Khamin waterfall in Thailand (**Fig. 19**). Notice in this photograph, you can see the path of the water. In a way, the mineral deposits, left behind in caverns, are a bit like this long-exposure photograph of the water; they tell us where the water flowed, and the basic pattern of the flow itself. Don't forget, this flow is affected by wet and dry seasons, and so there is variation in the flow.

Take a look at this image of Bridal Veil Falls within Bristol Caverns, USA (**Fig. 20**). Even though water flow is essentially non-existent today, it is clear that water once did flow over this area. This couldn't possibly have been formed "one drop at a time." Next time you are on a cavern tour, look closely at the formations themselves. They actually "speak" much more loudly and clearly than most people think. And, generally, many formations seem to indicate that there was much more water flow in the past. If this is the case, then the formations of the calcite would have formed much more quickly than what we see happening today.

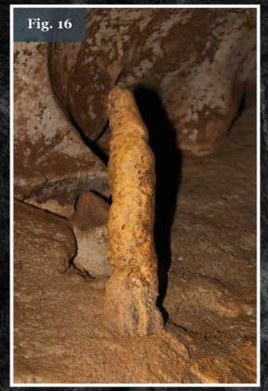


Fig. 16


Fig. 17

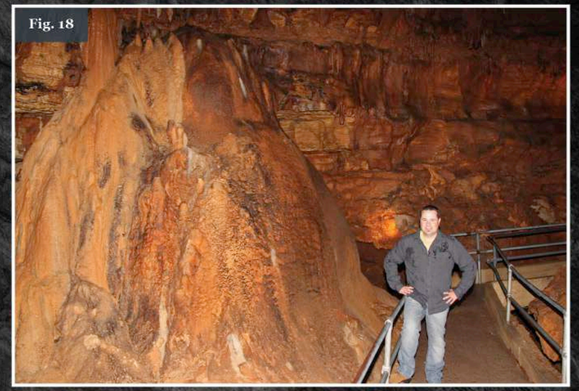


Fig. 18

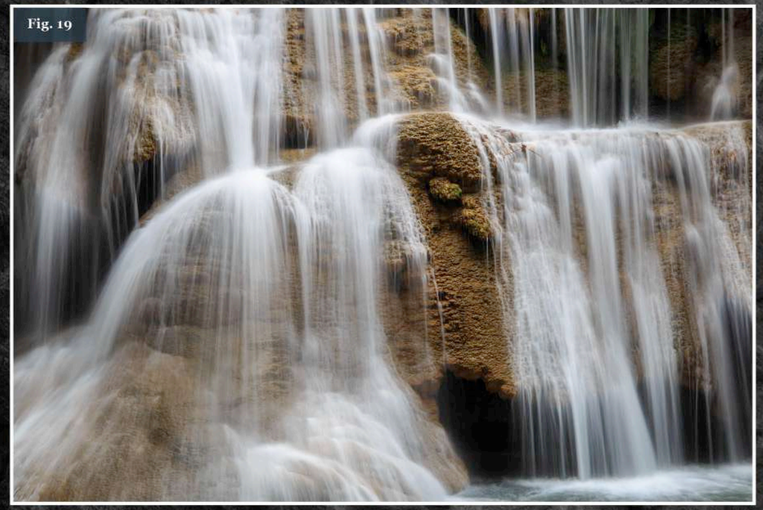


Fig. 19

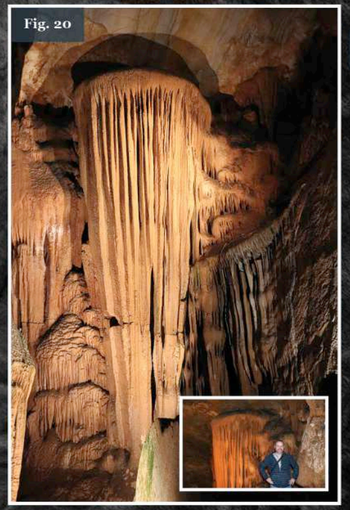


Fig. 20

What about Cave-like Formations On and Within Man-made Structures?

I have spent over fifteen years researching speleothems. Much of this time, I have been involved in researching calcite formations on concrete structures. In fact, when I began this research, it was still being claimed by some within the old-Earth secular geology community that these structures were not even calcite.

However, I studied (and collected many samples) from all over the world, including locations such as Canada (**Fig. 21**), USA (**Fig. 22**), UK (**Fig. 23**), France, and Korea (**Fig. 24**), and subjected many of them to sophisticated XRD analysis (X-ray diffractometry), thus proving that they were in fact made up of calcite, and in some cases contained minor amounts of aragonite. Compositionally, they were identical to those found within caverns.

Having been confronted with this fact, the argument of old-Earthers and secular geologists has changed. They now argue that though they are indeed calcite, they form differently than those found in caverns.[35] That is to say that the chemical pathways which form speleothems on concrete structures differ from those which form speleothems within cavern systems.

To test this suggestion, I travelled to multiple locations in Canada and the United States. At five locations where concrete was producing calcite formations, I personally tested the pH of the dripwater. The pH of the dripwater coming from the stalactites was very high (pH of over 13).[36] This seems to indicate a calcium hydroxide solution, rather than a calcium bicarbonate solution (pH between 6.6 and 9.5).[37] If the chemistry was the same as that in caverns, the pH should be between 6.6 and 9.5, indicating a calcium bicarbonate solution. I performed other tests as well.[38]

This being the case, the calcite apparently forms by the absorption of carbon dioxide from the air,[39,40] rather than by losing carbon dioxide from the solution (known as degassing) as happens in caverns. So, it is almost certain that in more recent concrete structures (around fifty to seventy years old), the chemical pathway differs from that which occurs in caverns during the formation of calcite. It is best, therefore, not to use speleothems on concrete structures as evidence for their rapid formation. Without testing the pH of the dripwater (and/or other tests), one cannot know what chemical processes are producing the calcite.

Nevertheless, old-Earth geologists admit that if the concrete or mortar is sufficiently old, it could have carbonated, that is turned back into calcium carbonate by absorption of carbon dioxide. If this is the case, then the calcite (or aragonite) speleothems forming from these man-made structures can in fact be produced by the identical process we see in caverns. Garry K. Smith explains, "As time passes, the available [calcium hydroxide] $Ca(OH)_2$ will leach from the cement paste along the seepage path and the pH will fall even further. If the pH falls below approximately pH 9[,] carbonic acid (H_2CO_3) will start to appear...and the chemical reaction will change to a similar process to that which occurs in limestone caves."[41] Though the exact time of this process differs, those familiar with concrete know it will occur.

Chirk Tunnel in Wales, near Wrexham,[42] was built with brick and mortar. It was completed on November 25, 1801 (**Fig. 25**).[43] It is 420 m (1,378 ft) long.[44] Calcite ribbons are growing within the tunnel (**Figs. 26** to **28**). A pH meter was used at various locations on the dripwater where speleothem growth was occurring, indicating readings between 8.2 and 8.9. This pH suggests that the mortar between the bricks has carbonated (turned back into limestone). Therefore, any calcite forming today is forming chemically by the same process that occurs within caverns.[45]


Fig. 21


Fig. 22


Fig. 23


Fig. 24


Fig. 25

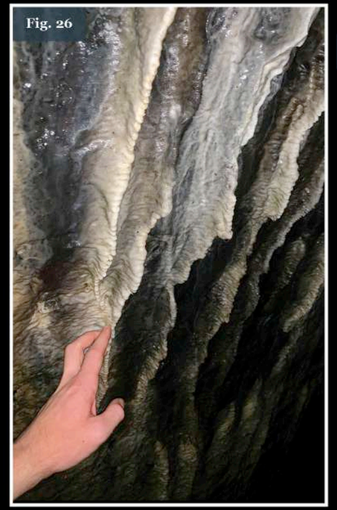


Fig. 26


Fig. 27


Fig. 28