

## Amazing Caves

Since the dawn of humankind, people have used caves—to explore, hold religious ceremonies, create art, or avoid the dangers of weather and predators. Partly because of that, they continue to fascinate scientists today.

To create a cave, Mother Nature needs three things: water, rock that can be dissolved by it, and lots of time.

Rainwater, as it falls through the atmosphere, picks up carbon from CO<sub>2</sub> to become a weak carbonic acid. By the time it hits Earth, it's about as acidic as coffee. As it percolates through the soil, it picks up more carbon from decaying plants, becoming a slightly stronger acid.

If the rock below the soil is limestone, gypsum, or dolomite, the water can dissolve along tiny cracks. Over many thousands of years, the cracks become channels, then tunnels, and could eventually become caverns.

Water might also mix with hydrogen sulfide gas seeping up from natural oil and gas deposits to form sulfuric acid, which can also dissolve the rock.

Protected from daily and seasonal changes on the surface, caves can maintain a stable temperature and humidity.

In these delicate environments, the remains of ancient animals and humans, which could have quickly decayed on the surface, have been preserved for millennia. Deeper, more isolated caves have preserved bacteria and microbes undisturbed for millions of years.

These qualities make caves important sites for researchers—natural time capsules. There's probably an amazing cave near you, so take a trip and get to know your Earth.



The Chandelier Ballroom in Lechuguilla Cave, featuring the largest known gypsum stalactites in the world. Each is tipped with a spray of gypsum crystals. For scale, note the man standing near the bottom of the photo.

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# Background: Amazing Caves

**Synopsis:** Caves evoke awe and inspiration. Early humans all over the world used caves for shelter and ceremony, and modern humans preserve caves as national treasures. How and where do these mystical natural features form?

- Caves are natural underground spaces with an opening to the surface. Shallower openings are referred to as *rock shelters*.
  - From the time of early humans through recent native civilizations, humans have used caves for shelter and often decorated them with paintings.
    - Neanderthals were named after the Neander Valley of Germany, where their first remains were found in a cave. Recently, some cave drawings have been dated to the time of the Neanderthals.
    - The first skeletons of Cro-Magnon humans were found in a rock shelter in France called *L'Abri Cro-Magnon* ("the shelter hole of [landowner] Magnon"), and many caves in the region host incredible paintings and engravings by early *Homo sapiens sapiens*.
- Most caves are solution caves that form over thousands to millions of years by dissolution of rock. Any rock that will dissolve can host a cave, but most caves occur in limestone bedrock.
  - Limestones and other carbonate rocks are more reactive than other sedimentary rocks because they are prone to dissolution by chemical erosion through karst processes.
  - Rain becomes slightly acidic (approximate pH of 5) when it picks up carbon dioxide from the atmosphere, and it becomes even more acidic as it filters through organic-rich soil, resulting in a weak acid: carbonic acid ( $H_2CO_3$ ).
    - As the acidic water percolates into the rock through pores, along bedding planes, and into joints and fractures, it reaches the saturated zone below the water table, where groundwater is constantly in motion.
      - ✦ Here, carbonic acid slowly dissolves the limestone and progressively enlarges the percolation pathways into a subterranean plumbing system ranging from channels to tunnels to caverns.
  - The shape of the cave is often controlled by the orientation of the formation's original bedding and joints, and may also reflect paleowater table locations.
- In some cases, as the water table drops below the level of the cave over time, the dissolution cycle reverses.
  - Exposure to air causes the saturated fluids to release  $CO_2$ , decreasing the acidity of the water and precipitating carbonates, including beautiful dripstones called *speleothems*.
    - Stalactites extend downward from the cave's ceiling, and stalagmites build upward from the cave floor.
  - Many caves are partially below the water table, causing them to be flooded with moving groundwater.
    - There are three types of these active caves:
      - ✦ If a stream sinks into a cave, it is called an *inflow cave*.
      - ✦ If a stream comes out of a cave, it is called an *outflow cave*.
      - ✦ If a stream flows through the cave, it is called a *through cave*.
    - If water is not flowing through a cave, it is called a *relict cave*.
- Karst processes usually result in distinctive undulating landforms known as *karst topography*, which include ridges and valleys, sinkholes, and underground drainages.
  - Sinkholes form after the failure of roofs of undetected water-filled caverns underground, especially if drought causes the water table to drop, leaving the ceilings unsupported.
    - Sinkholes have recently swallowed homes and businesses in Florida, Kentucky, and Texas.



## References: Amazing Caves

Cave | Wikipedia  
How Do Caves Form? | LiveScience  
Geology of Caves | USGS National Park Service  
Aquifers and Groundwater | USGS Water Science School  
Mammoth Cave | National Park Service  
Carlsbad Caverns | National Park Service  
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- Karst areas may lack surface water because it may trickle down through cracks in the rock all the way to the water table.
  - Rivers may disappear into holes and then suddenly reappear as springs.
- Water supplies in karst areas can be contaminated easily; they must be monitored as carefully as surface water because drainage into the aquifer can be so rapid that the normal filtering processes of the earth may be bypassed.
  - A particularly bad practice is the use of sinkholes as dumps, which puts garbage pollution in direct contact with the aquifer.
- An extremely beautiful type of solution cave forms when hydrogen sulfide ( $H_2S$ ) percolates upward from oil and gas reservoirs and mixes with groundwater to form sulfuric acid ( $H_2SO_4$ ), which dissolves the host limestone.
- Both Carlsbad Caverns and Lechuguilla Cave in New Mexico have intricate speleothems made of sulfates such as gypsum ( $CaSO_4 \cdot 2H_2O$ ).
- Other types of caves form by other processes:
  - Sea caves form along the shore because of wave activity.
  - Lava caves are left behind as lava tubes that cool on the outside then drain out their molten lava.
  - Glacial caves form because of the interaction of water and ice.
- Check with the National Park Service and your state park service to learn more about caves in your area.



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