Geology of Jewel Cave

National Park Service
U.S. Department of the Interior

Jewel Cave National Monument

A Big Cave

From the surface, not many would expect that just beneath them lie hundreds of miles of cave passages. Jewel Cave is one of the longest and most complex cave systems in the world. With the majority of passages awaiting discovery, explorers continue to push their limits and traverse the vast underground maze of interconnected passageways. Currently, over 200 miles have been explored.

Beginnings

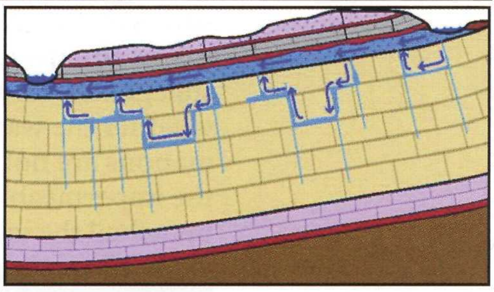
Jewel Cave's geological history begins 360 to 320 million years ago. During the Mississippian period, the Black Hills region was submerged in a shallow sea and the Pahasapa limestone formed—the rock layer where Jewel Cave is located! The Minnelusa Formation covered the limestone with a sandstone layer at its base and afterwards thousands of feet of sedimentary layers were deposited above.

Then 65 to 35 million years ago, the Black Hills uplift (Laramide Orogeny) caused igneous and metamorphic rocks to slowly lift thousands of feet, causing the limestone to fracture. The overlying layers eroded simultaneously with the uplift.

Forming the Cave

Stage 1

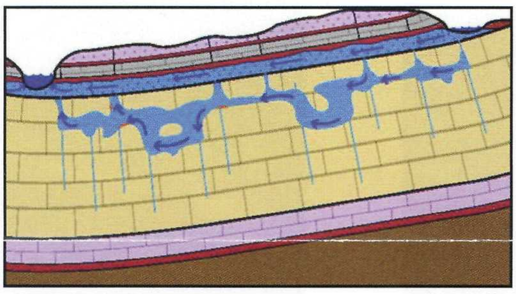
Around 16 million years ago, erosion began cutting into the sandstone at the base of the Minnelusa Formation and water began moving downhill through the sandstone from one stream (a losing stream) to another (a gaining stream). Along the way, some of the water from this aquifer began circulating through the fractures in the limestone.



Stage 1

Stage 2

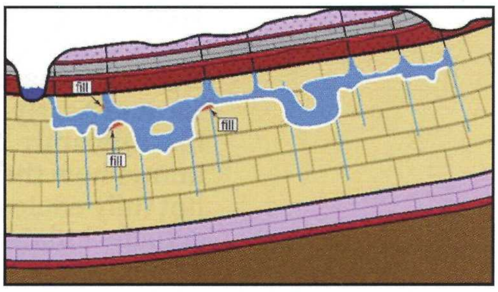
The water contained carbonic acid, probably derived from carbon dioxide in the soil along the banks of the losing stream. It moved generally westward, following the tilt of the limestone. The acidic water continuously dissolved and removed limestone, gradually enlarging the fractures into passages.



Stage 2

Stage 3

Stream erosion cut completely through the sandstone layer around 15 million years ago. The aquifer drained, the streams dried up, and the cave water stopped flowing. Without the weight of the water in the aquifer, pressure was reduced, so carbon dioxide began bubbling (*degassing*) out of the cave water and it stopped being acidic. Without the acid, the water became supersaturated with dissolved limestone, which forced it to deposit the limestone in its crystalline form, calcite. The calcite crystals, known as nailhead and dogtooth spar, are the "jewels" of Jewel Cave. The deposition of spar marked the end of cave passage development.

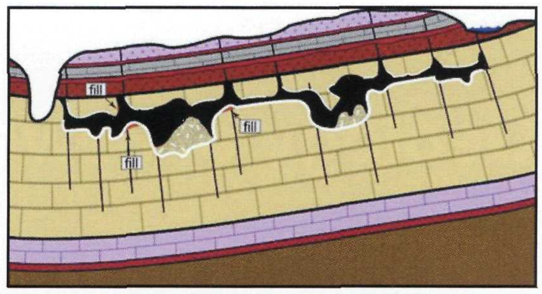


Stage 3

Forming the Cave... Continued

Stage 4

Since then, the water slowly drained from the cave through unenlarged fractures and has been replaced by air. Without the buoyancy provided by the water, many of the larger rooms partially collapsed into piles of limestone breakdown.

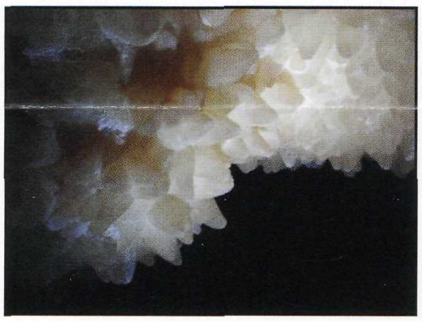


Stage 4

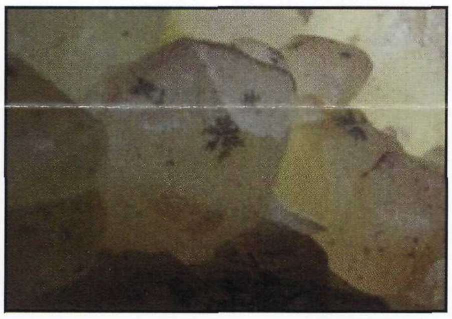
Barometric Wind

The volume of air in the cave is so great that it is affected by changes in barometric pressure. When the outside pressure drops 1%, the cave air expands 1% and exhales millions of cubic feet of air with wind speeds up to 35 miles per hour in some places. When the pressure rises 1%, millions of cubic feet blow in. This airflow allows scientists to estimate the size of Jewel Cave. Currently, only three percent of the total volume of the cave has been discovered.

Jewels of Jewel Cave



Dogtooth Spar

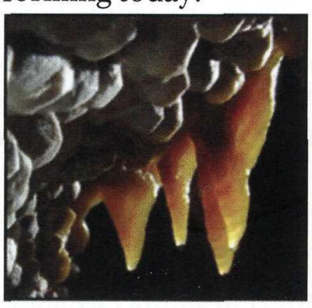


Nailhead Spar

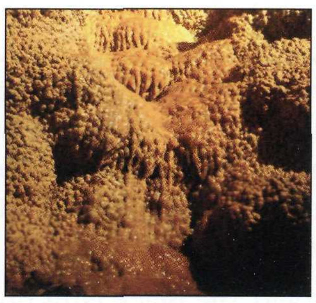
Dogtooth spar, sharp-ended calcite crystal, is formed in isolated pockets with limited water circulation. The blunt **nailhead spar** is the most common calcite formation in the cave and covers most of the cave surfaces.

Speleothems

After the cave water drained away, surface water began dripping and seeping into a few air-filled passages and began forming **speleothems** (cave formations). Many of these are still forming today.



Stalactites



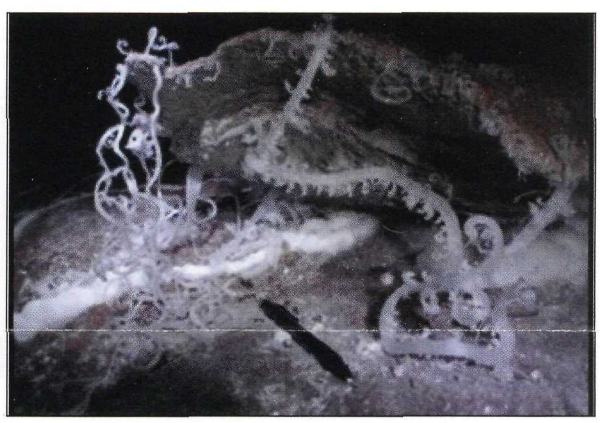
Flowstone

Draperies

Popcorn

Calcite speleothems form when surface water makes its way through carbon dioxide-rich soil and travels underground through fractures in the limestone. The resulting carbonic acid dissolves the limestone. When the water enters an air-filled cave passage, the carbon dioxide degasses and the dissolved limestone is deposited as small crystals of calcite, creating stalactites, stalagmites, flowstone, draperies, and popcorn. The type of formation created depends whether the water is dripping, trickling, or seeping when it enters the cave passage. These formations are not common in Jewel Cave because 99% of the known cave system is dry due to the impermeable Minnelusa shale layers above. Water only enters the cave where erosion has breached the layers of shale.

Hydromagnesite is formed from seeping water with high concentrations of magnesium carbonate. Sometimes it takes the form of pearly-white formations that look like miniature balloons. However, no one knows how they form. Most balloons are not fully enclosed and probably were not actually inflated.



Gypsum speleothems form when seeping water contains gypsum (hydrated calcium sulfate) picked up from certain layers in the overlying Minnelusa Formation. When this water evaporates in the cave, it deposits gypsum in the form of flowers, needles, beards, or spiders. Gypsum formations are found only in relatively dry parts of the cave.

Various manganese oxides and hydroxides, generally referred to as "manganese," can be seen on tours of Jewel Cave. The black manganese stands out in the lower levels of the cave, often coating the crystals and shading the surface gray or purple.