



Zenithal ceiling tubes, a peculiar karst corrosion form in Carlsbad Caverns (New Mexico, USA)

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Carlsbad Caverns is a world renowned show cave located in the Guadalupe Mountains (Chihuahuan desert, New Mexico) and managed by the United States National Park Service. The cave is hosted in the Permian Capitan Reef limestones that border the Delaware basin. It consists of elongated passages connecting wide rooms that extend to a depth of almost 300 m beneath the natural cave entrance, almost 200 m below the floor of nearby Walnut Canyon.

As most caves of the Guadalupe mountains it has formed by rising hydrogen sulphide deriving from underlying oil and gas deposits, producing sulphuric acid by mixing with fresh water which corroded the limestone into unusually large chambers. This H₂SO₄ speleogenesis has produced gypsum that is present under various forms. Carlsbad Caverns has been widely studied by generations of cave scientists, and research has especially focussed on speleothems, mineralogy, speleogenesis, cave fauna and, mostly in the last decennia, microbiology. This has resulted in a large number of publications in many scientific journals, making Carlsbad Caverns one of the best studied caves of the world.

During a trip to the Hall of the White Giant, in the squeezing crawlways that connect the main Corridor to the Sand Passage, several cylindrical vertical upward developing holes were observed on the ceiling at several heights. They have a circular cross-section with diameters of 1 to some centimetres and taper out towards their upper end. Their walls are smooth and their edges sharp. Their length can reach several decimetres. Sometimes gypsum can be found inside. They often occur randomly distributed in groups and their development is not necessarily controlled by fractures or other bedrock structures.

These holes are similar in shape to the bellholes described from many tropical caves, but are much smaller. They also look like the holes described by Stanton (1986) from caves in the Mendip Hills. This author believed they formed by activity of snails (they were coined “snailholes”). The Carlsbad holes are also very similar to the tubular lake shore karren described by Simms (2002) from Irish lakes formed by condensation-corrosion processes with air pockets trapped by changing water levels.

In the case of the Carlsbad caverns the holes are created by the corrosive effect of sulfuric acid. H₂S(g) dissolves in water films on the rock surfaces giving rise to widespread sulfuric acid corrosion. When H₂S bubbles are trapped underneath overhanging surfaces or ceilings and water level rises steadily the corrosive effect is concentrated vertically upwards, drilling vertical holes that can also completely pass overhanging rock ledges.

We prefer to call these peculiar karren-like forms “zenithal ceiling holes” instead of “röhren (tube) karren” used by Simms because of their origin by corrosion processes and their upward growth.