Quartzite Caves of the Venezuelan Table Mountains – Speleothems

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Caves formed in silicate rocks often host siliceous speleothems formed dominantly by opal. Unlike in carbonate speleothems, microbial mediaition is much more common during formation of siliceous speleothems. Siliceous speleothems commonly represent small forms, rarely exceeding 2 cm in size. The speleothemes occurring in the investigated quartzite caves of the Venezuelan quartzite caves of the Macizo del Chimanta and Roraima table mountains during our expeditions in 2007 and 2009 are characterized by enormous variability in size and morphology and most of them bear signs of microbial origin. Many of the speleothems remind classical stalactites and stalagmites known from limestone caves but their structure and genesis are different. Apart from variable shapes, the microbial speleothems show identical principal texture, corresponding to various stages of their evolution. They consist of two principal zones:

1. Laminated **columnar stromatolite,** consisting of finely laminated non-porous layers of pure compact opal, intercalated by some zones of filamentous microbialite, with thin filaments oriented in the direction of the stromatolite growth. SEM study of the etched surfaces of the columnal stromatolite showed that it mostly consists of concentric laminae formed by dense parallel tubes representing casts after filamentous microbes. The microbes are most similar to filamentous cyanobacteria from the order Oscillatoriales (Golubic, 1976). In other places, irregular, larger-scale, double-layered cross-sections of microbe tubes occur. They resemble casts after cyanobacterial cells of the genus *Cyanostylon* or Entophysalis (Golubic, 1976).

2. Strongly porous zone **peloidal microbialites** formed by white chalk-like opal, represents accumulation of microbial peloids and forms mostly the outer zones of the speleothems. The peloids are densely packed, arranged in concentric laminae. The size of peloids varies from 0.1 to about 0.3 mm. Microscopic study revealed that the peloids are formed by *Nostoc*-type cyanobacteria. Fungal hyphae, metazoan and plant remains also subordinately contribute to speleothem construction. In many places, initial colonization of the surface by *Nostoc*-type cyanobacteria was observed, forming mats and shrubs covering the underlying arenites. The microbial filaments are commonly encrusted by white silica, whereas the surrounding arenites are intact. This is a strong evidence that the microbes were not only passively encrusted by silica but the encrustation was microbially mediated, either by their metabolism, or by changing physico-chemical cionditions. This phenomenon is common in the limestones but it was not yet evident for the siliceous microbialites. Presence of cyanobacteria, which are otherwise phototrophic organisms in caves is not so surprising as it seems to be. Some cyanobacteria do not withstand an excess solar light that can damage their cells (Vincent and Roy, 1993; Quesada and Vincent, 1997). Some of them produce protective pigments in extracellular sheath (e.g.. *Lyngbya estuarii* produces pigment scytonemine - Kylin, 1937); others are even able to protect themselves against the excess light by boring the substrate, e.g. endolithic boring cyanobacteria *Hormathonema* and *Hyella* (Golubic, 1976). The genera *Fisherella* and *Calothrix* are even able to

change their mode of life to slow heterotrophic in complete darkness (Whitton, 1987). The most convincing fact is that some cyanobacteria, e.g. *Geitleria calcarea* and *Scytonema julianum* were found to live in caves (Friedman, 1955; Bourelly and Depuy, 1973). It is obvious that the cyanobacteria in Venezuelan caves are also adapted to heterotrophic life mode.

Some speleothems, e.g. the cobweb stalactites represent mostly inorganic precipitates, encrusting various structures, such as spider threads. There are also large inorganically precipitated stalactites and flowstones. Comparing the size of the speleothems from various caves, there seem to be dependence between the cave size and speleothems size. Cueva Charles Brewer and Cueva Colibri hosts the largest recorded silica speleothems (up to several dm in size) whereas those in other caves were not so large (cm to dm. size).

The reason for the size dependence between the caves and the speleothems is yet unclear. One of the possible explanations would be that the larger the cave is, the more siliceous material undergoes the dissolution/reprecipitation cycle. Larger cave corridors and galleries e.g. of the Cueva Charles Brewer have several times larger surface than other caves available for the condensed air moisture which plays the most important role in the cycle.

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