Quartzite Caves of the Venezuelan Table Mountains – Speleogenesis

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The recently most accepted model for the genesis of the sandstone caves in the Venezuelan tepuis is the arenization concept presented by Martini (1979). The term "arenization" involves the dissolution of the cements in the arenitic rocks, with subsequent erosion and winnowing of the loose sand material. If the "arenization" theory was true, most of the sandstone caves could really be attributed to karst as the dissolution is considered there to be trigger process of the cave formation.

This model is fully accepted for description of quartzite caves e.g. by Briceño et al. (1991). The arenization model was also used to explain the origin of the Aonda karst system of the Auyán table mountain in Venezuela by Mecchia and Piccini (2009). However, our findings gained during two expeditions in 2007 and 2009 on the Macizo de Chimanta and Roraima table mountains in Venezuela showed that the role of quartz and/or quartz cements dissolution dominancy is questionable, therefore we propose use term "pseudokarst" for these phenomena, instead of the term "karst".

Geological and geomorphological research showed that most feasible way of the caves genesis is winnowing and erosion of unlithified or poorly lithified arenites. The unlithified arenitic beds were restricted by well-cemented overlying and underlying rocks. There is a sharp contrast between these well-lithified rocks and the loose sands which is the content of the poorly lithified to unlithified beds. They are only penetrated by well-lithified pillars formed by vertical finger-flow of the diagenetic fluids from the overlying beds. Such finger flow is typical for loose sands and soils only with containing beds with sharp difference of hydraulic conductivity. The pillars are apparently more resistent against erosion, whereas the surrounding loose sands are easily eroded. The caves are formed by erosion by flowing water accessing the poorly lithified beds through clefts. Collapse of several superposed winnowed horizons can create huge subterranean space, e.g. the Gran Galeria Karen y Fanny of the Cueva Charles Brewer cave, the biggest known quartzite cave in the world. Futher propagation of the collapses upward can lead to large collapse zones which are commonly observed on the tepuis.

Quartz and/quartz cement dissolution is also present but probably plays neither the trigger role, nor volumetrically important role in the cave-forming processes. The strongest observed dissolution/precipitation agent is the condensed air moisture which is most likely the main agent contributing to growth of siliceous speleothems. As such, it can be active only after, not before the cave is created.

Another frequently observed phemomenon in the cave systems of the Macizó del Chimantá is the red coloured mud, so-called "barro rojo" often forming huge flow bodies, up to 5-6 m in diameter. Following the results of X-ray difraction analyses this material contains kaolinite and goethite which originated by weathering of alumosilicate minerals, i.e. by their incongruent dissolution in acidic waters. Following this finding we suppose that the above described proces probably also contribute to the quartzite caves speleogenesis by weathering of sandstone layers with higher alumosilicate minerals contents (e.g. feldspars, mica, etc.).

Summarizing the information presented in the paper we conclude that the most important factor of quartzite caves speleogenesis is the predisposition of the quartzite rock bodies propagated in non-uniform lithification leading to their non-uniform erosion. Other two observed processes are corrosive. Alumosilicate weatherig (lateritization) may significantly contribute to the cave genesis, whereas quartz and/or quartz cement dissolution by condensed air moisture is less significant for the speleogenesis. The lateritization in broader sense is the only factor for which we may admit the studied caves can still be ranked among karst phenomena.

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