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Genesis and evolution of the caves in the Naica Mine (Chihuahua, Mexico)

P. Forti

Italian Institute of Speleology, Dept of Earth Sciences, Bologna, Italy (paolo.forti@unibo.it)

The Naica caves and their large gypsum crystals were discovered almost a century ago, but only recently three new caves were unveiled, the largest of which (Cueva de los Cristales) hosts by far the largest gypsum crystals of the world.

At the beginning of 2006, thank to an agreement between the owner of the Mine (Peñoles Company) and the Speleoresearch & films of Mexico City, the "La Venta" Exploring Team was allowed to co-ordinate an interdisciplinary project to study any aspect of these caves.

Anyway, until now, studies were focused on the mechanisms allowing for the development of the giant crystals while the genesis and the evolutionary steps of the Naica caves were completely neglected. The aim of the present paper is to fill this gap.

The thermal fluids responsible, since 25 Myr BP, of the evolution of the Naica ore bodies were always characterized by net deposition, therefore the permeability of the hosting formation was greatly reduced and no karst voids had the possibility to develop.

Very recently (1-2 Myr BP), when the temperature of the thermal water cooled below 100˚C, tectonic stresses partially displaced the ore bodies giving rise to open joints and fractures closely related to three main faults (Naica, Gibraltar e Montañas), which still now control the uplift of the thermal fluids.

Since then the thermal waters became aggressive with respect to carbonate formations, thus small cavities had the possibility to develop at different levels inside the aquifer. This process lasted for a relatively short time interval as testified by the clear tectonic

shape maintained by all these cavities.

The few corrosional features (mainly bell domes over the ceilings) did not allow for a detailed reconstruction of the cave evolution, which was instead achieved through a multidisciplinary analysis of the thick deposits hosted inside each cave.

The evolutionary steps were several and complex, related to different speleogenetic mechanisms (corrosion, double exchange, acid aggression, CO_2 diffusion, condensation corrosion, etc..). Even if always they were controlled by the presence of the thermal aquifer, the resulting evolution was somehow different from cave to cave, being, time by time, related to deep phreatic, epi-phreatic and vadose environments.

From this point of view the most interesting cave is the Cueva de las Espadas, the evolution of which was characterized by several changes between these three environments, while the deeper caves (Cristales, Ojo de la Reina and Velas) suddenly changed from deep phreatic to vadose when the mine dewatering lowered the groundwater below the -290 level some 20 years ago.

The anthropogenic processes induced by the mine depression cone had relevant consequences on the cave development giving rise to the evolution of several new diagenetic minerals but also greatly enhancing the condensation corrosion and dissolution processes which, in a few years, will be responsible not only for the damage of the giant gypsum crystals but eventually for their complete destruction.