



Dolines in Sierra de Quemado and their relationship with the development of the Gran Caverna de Santo Tomás, Vinales, Cuba

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Dolines are the most representative landforms of karst territories, and have a very significant development in the tropical karst. In the Sierra de los Órganos (West Cuba), the doline development in size and depth has been taken in consideration in several papers, especially after the classic works of Herbert Lehman in the 50's. Recent studies have revealed that horizontal and vertical development of doline is conditioned by tectonics, their spatial location, and is strongly controlled by the local base level. In the Sierra de Quemado, about 30 dolines were recognized with a remarkable variability in shape, size and depth. They are mainly collapsed dolines with different deepening phases, clearly marking the various evolutionary stages of the system, and working as individual entities to control the surface erosion, notably influencing the configuration of the main karst system such as the Gran Caverna de Santo Tomás.

Collapse dolines originate as a consequence of the loss of mass, due to speleogenetic processes and the likely fall of the roofs of caves that developed below the dolines. The successive evolution of dolines often took place for the proximity of a cave (active or not), evolving parallelly. When doline deepening reached this level, the retraction of the walls began, which also had an influence on the hypodermic cavities observed in the dolines, and on some foot-caves ("marginal caves" or "füsshölen") that acted as important recharge points. Instability of part of the slope will cause its final collapse. Vertical jointing and faulting, together with the high values in the angles of internal friction, thoroughly contribute to the process of slope recession. Because of their different phases and evolutionary stages, the ranges in the morphometric values of dolines are high: some dolines have dimensions similar to "Tiankeng", with more than 100 metres in diameter and depth.

As a rule, the different deepening phases that mark the evolutionary stages of the area can be appreciated in the doline profiles, evidenced by the relationships with the present and past cave networks. This is especially shown by the transfluent character of the system of galleries and the drainage network developed in the territory, and fed by sources of allogenic recharge that penetrate the massif at the base level and in the epiphreatic zone. In turn, each one of the evolutionary stages of the dolines coincides with the cave levels of such transfluent cavities. At the bottom of those reaching the present base level, the collapse is masked in some sectors by the presence of allochthonous sediments transported from outside the massif. All these findings are based upon morphometric, logical-combinatory-boolean, and structural analysis, as well as by a number of topographic profiles, that allowed to characterize statistically the doline features in connection with the cave system of the Gran Caverna de Santo Tomás.