“Hypogenic karstification: a so far unrecognized stage in the evolution of travertine buildups – from field studies to numerical modelling” – popular science summary

Travertines are freshwater limestones accumulating in running water downstream of springs fed with highly mineralized waters, often thermal, enriched in CO_2 derived from natural processes in the Earth’s interior. Travertines accumulate in spectacular buildups that extend for up to 10 km and are up to 300 m high. These rocks are present on all continents, except for Antarctica. The most spectacular carbonate buildups are popular geotourist sites, and some are included in the UNESCO World Heritage List. First notes on travertines and their properties come from ancient Rome and are older than two millennia. It was Pliny the Elder who noticed the peculiar properties that make travertines a valuable construction material. Travertines have attracted attention of researchers at the beginning of the 21th century when their wide distribution and high deposition rates (up to tens of centimetres per year) had been appreciated as providing a high resolution tool for time-calibrated palaeoclimatic, hydrological and tectonic reconstructions. Travertines have also been recently recognized as having high reservoir potential for various resources, including hydrocarbons.

Travertine deposition has been extensively studied in recent decades, hence the environmental factors that control their growth and morphology are quite well known. Well studied is also the impact of tectonic processes on travertine accumulation and on tectonic deformation during their growth. However, much less is known on the processes that affect travertines after their deposition. Results of pilot studies in Slovakia suggest that travertine buildups are internally karstified to a significant degree. A part of the dissolution voids is completely or partly filled with secondary carbonate deposits, laid down below the groundwater table. Moreover, literature data suggest that travertine buildups in various parts of the globe bear traces of internal dissolution. Compelling is thus a hypothesis that subsurface dissolution of travertine buildups is an important, though not yet studied, stage in their life. As origin of travertines is related to deep-water circulation, coupled with ascending flow of CO_2 generated deep in the Earth’s crust, it is justified to attribute the observed dissolution to hypogenic karstification – one caused by aggressive solutions rising to the surface. Verification of this hypothesis is the main goal of this project. The project also aims at determining the causes and the course of subsurface karst dissolution within the travertine buildups, at identification of the factors involved and of conditions suitable for the processes.

Comprehensive geological studies on travertine buildups are planned in Slovakia, Italy and Turkey. At the pilot stage, study sites will be selected. Then, detailed field surveys will be conducted, including sample collection. The next step will consist in making a wide variety of laboratory analyses of the travertines and their internal deposits, aimed at studying their structures, chemical, isotopic and mineral composition, porosity and fracture systems (including the use of computer imaging - microtomography), and isotopic dating using the uranium-thorium method. The obtained results will serve as the basis for working hypotheses, later verified within a broad palaeohydrological and structural context. It is at this stage when numeric models will be constructed, representing conditions of karst development within travertines. The final result will be a synthetic universal model depicting the development of hypogenic karst in travertine buildups, including the successive stages of the process.