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Experimental evolution of thermal water-related precipitates

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Calcium carbonate precipitates of thermal springs are well studied in natural systems and also by in vitro experiments. Limitation of in vitro experiments is that the number of factors governing the precipitation is less than in natural systems. In contrast, the precipitates cannot be linked to specific parameters of the water in natural systems. In situ experiment in an artificially created “natural environment” can be a key tool to overcome these problems.
The Buda Thermal Karst in Hungary is an active hypogenic karst system, therefore it is a good natural laboratory to study dissolution and precipitation processes. Two main precipitates are known in the spring caves and hypogenic caves of the area: carbonates and iron-manganese oxyhydroxides, associated with biofilms. A 3-month-long in situ experiment was carried out to study thermal water precipitates in time and along the flow path, in the light of the changing physicochemical parameters.
As a first step, a one-day-long experiment was carried out to study the changes of the main physicochemical parameters (temperature, pH, dissolved oxygen content, specific electric conductivity, concentration of major ions) along the flow path of the thermal water. The measured values were compared to the results of a reactive transport model. On the basis of the measurements and the model, continuous calcium carbonate precipitation was expected.
Based on the first experiment, a second, longer phase was planned and designed, during which the continuous thermal water outflow was directed into an artificial channel for three months. Glass slides perpendicular to the flow direction were put into the channel at key distances from the discharge point. The evolution and morphology of the precipitates were studied by stereo microscope, transmitted light microscope, scanning electron microscope and X-ray powder diffraction.
Intense red coloured, amorphous iron-oxyhydroxide formed close to the discharge point, while further away light red, then yellowish grey calcite. Rhombohedral and dendrite calcite crystals were observed.
Rod-shaped bacteria and the first crystals were detected after one day.
As a conclusion, the coexistence and interrelationships of microbiological and physicochemical processes were demonstrated.
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