Rates and controls on early diagenesis in continental spring carbonates – a lab experimental approach

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Carbonate precipitates at continental springs are regarded as interesting archives of environmental changes. However, much overlooked and poorly understood are the changes that happen to the CaCO3 crystal textures and chemistry just after precipitation, both under the influence of changing spring waters as well as during intermittent, short exposure and infiltration of meteoric waters.

Detailed field, microscopic and micro-CT observations of modern to Holocene travertine core transect at Mammoth Hot Springs (Yellowstone NP, USA) indicate that these changes in $CaCO_3$ fabrics, aragonite to calcite mineralogy and isotopic signature can be pervasive and thus significantly alter the environmental record preserved.

Virtually no information is however available on how fast these processes take place (rates), the diagenetic transformation pathways and what factors execute a dominant control (flow, temperature, water chemistry, biota). In this study high-resolution, microscopic observations (SEM, CSLM) of field samples and in-situ precipitation experiments are integrated with controlled lab experiments in an open flume setting, mimicing low to highly saline, spring water chemistry. Natural, fresh precipitates are used to run a series of meso-scale experiments, together with regular μ-CT observations and monitoring of water parameters (pH, T, water chemistry, flow, light).

The natural analogs consist of a low saline Ca-HCO3-SO4 spring in Köröm (Hungary) and a high saline and Fe-rich Ca-Na-HCO3-Cl-SO4 spring at Eot (Edipsos, Greece). Both have in-situ vent temperatures between 75 and 80°C and precipitate both aragonite and calcite along the outflow path. The microscopic, 3D images and stable isotopic changes are compared between field and lab examples and the predictability of precipitation and alteration rates and CaCO3 mineralogy changes, using geochemical modelling is discussed.