Ber. Inst. Erdwiss. K.-F.-Univ. Graz	ISSN 1608-8166	Band 20/1	Graz 2014
PANGEO AUSTRIA 2014	Graz, 14. September 2014 – 19. September 2014		

Ikaite ($CaCO_3 \cdot 6H_2O$) formation in a river bed – a rarely documented carbonate mineral

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Ikaite – calcium carbonate hexahydrate – is a worldwide rarely documented carbonate mineral and, to our knowledge, was never reported from Central Europe before. This mineral is metastable and needs particular and narrow conditions in order to precipitate from solutions, i.e. a very limited water temperature range between 0 and 4 °C, highly alkaline conditions, high supersaturation values, and in many cases carbonate precipitation inhibitors (e.g. phosphates). Outside these conditions it disintegrates into calcite and water within minutes to hours. The few places of ikaite formation include Ikka Fjord in Greenland, Arctic- and Antarctic sea-ice and some sites of water mixing at Mono Lake, California.

The ikaite precipitates in our study formed in a partially man-made river bed, i.e. a small natural river was bypassed flowing through a new bed lined with concrete and blocks. During winter, when water temperatures dropped down close to freezing, hydrochemical investigations showed very high pH values up to 13.0, elevated Ca^{2+} concentrations up to 200 mg/l and centimetre-thick, beige-colored and soft crusts precipitated along the artifical and natural river bed.

In order to better understand the particular water-rock-interaction, a hydrochemical monitoring program was launched and several of the delicate precipitates were recovered in refrigerator boxes in their original solution. The samples were analyzed in the laboratory within a few hours after sampling and stored at 1 °C. XRD and FT-IR patterns clearly revealed the predominant occurrence of ikaite next to minor amounts of other carbonates (calcite, aragonite, vaterite) and detrital minerals. Crystal aggregates were investigated by environmental-scanning-electron-microscopy (ESEM) and subsamples were dried at different temperatures in order to study stable isotopic fractionation and composition during transformation to calcite.

Combining detailed field monitoring results, solid-phase analyses and regional meteorological data (rainfall, water discharge, temperature) with hydrogeochemical modeling allows constraining the mechanisms of ikaite formation, as well as the temporal and spatial evolution of the waters and precipitates in the river bed.