Natural carbon sequestration by *ikaite* in Ikka Fjord, Greenland

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The marine Ikka Fjord in southwest Greenland is famous for its remarkable and unique submarine columns made of the cold-carbonate *ikaite* ($CaCO_3 \cdot 6H_2O$). Here, natural processes lead to fast-precipitating ikaite at low temperatures (< 6°C) when carbonate-bearing groundwater seeps through fractures in the seabed of Ikka Fjord and mixes with seawater. Within a 0.75 km^2 area, 678 individual columns of 1–20 meters height have been registered, continuously growing at rates measured of 40–50 cm per year.

Over the past 25 years, several biological, geological and geophysical studies have been carried out in Ikka Fjord describing the columns and the remarkable microbiological ecosystem they host inside, and the igneous rocks of the surrounding Grønnedal-Íka complex. The two components, the columns and the igneous rocks are clearly linked as demonstrated by isotopical, geochemical and petrological data, and by just looking at a map. All columns are growing within the spatial limits of the complex – and none outside it.

Through laboratory experiments conducted at the University of Copenhagen and Stockholm University, the geochemical parameters for ikaite precipitation and the role of microbiology for ikaite column stability has been investigated. Pure ikaite can be formed at temperatures up to 10°C by mixing seawater with pH 10–11 sodium carbonate solutions. Above 10°C, Mg carbonates and ACC start to co-precipitate with ikaite. Cyanobacteria and diatoms appear to play an important role for the protection of ikaite against seawater dissolution and erosion by their secreted extracellular polymeric substances (EPSs), which rapidly creates a microbial biofilm enveloping the ikaite crystals.

Understanding this natural system is of importance for carbon capture and storage efforts as it represents a very efficient method for carbon mineral storage in cold seawater.