

Unique *Ikaite* columns under pressure by warming seawater

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Over the past 25 years, numerous biological, geological and geophysical studies have been carried out in Ikka Fjord in SW Greenland describing its unique *ikaite* ($\text{CaCO}_3 \cdot 6\text{H}_2\text{O}$) columns and the remarkable microbiological ecosystem they host inside. In 1995-97, effort was put into mapping the columns and making a thorough geochemical description of how these columns form in Ikka Fjord. This is the only place on Earth they occur. In 2018-19, a new mapping campaign of the columns was carried out by use of drone imaging and multi-beam sonar surveys. In addition, seawater temperature was measured around selected columns at different depths combined with sampling of column pieces at the same spots as the temperature measurements. The column samples were analysed by X-ray diffraction (XRD) to check for possible mineral alteration. The overall goal was to record any changes to the columns that may have occurred over the past 25 years in response to warming seawater.

Our data shows that the seawater temperature around the columns has risen above the 6°C threshold judged necessary for a long-term stability of the *ikaite* mineral. In June 2019, the temperature of the water column ranged from 6-10°C compared to 0-6°C in the summers of 1995-97. The mineralogy of the columns have changed, from almost pure *ikaite* in the nineties to now partly altered into less hydrated CaCO_3 minerals, which we interpret as a response to seawater warming. The previous mapping campaign detected 678 individual columns above 1 metre's height, whereas the new survey identified 938 individual columns of 0.5-20 meters height. Thus, we conclude that the hydrological-geochemical system controlling new growth of columns is still functioning, but the long-term stability of the columns and thereby their microbial ecosystem is threatened by the warming seawater.