

# Sub-bottom profile survey Ikka Fjord, South Western Greenland - has the ikaite column garden resurrected?

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The Ikka Fjord in southwestern Greenland has gained wide interest from scientists in many fields for its world-unique ikaite columns protruding from the seafloor. The current understanding of column formation in the Ikka Fjord is that the mineral ikaite forms at low temperatures (<6°C) from the interaction of carbonate-rich groundwater with Ca-rich sea water creating supersaturation of calcium carbonates in the mixed solution (Buchardt et al. 2001). Seawater is containing Mg<sup>2+</sup>, too, which inhibits the formation of anhydrous calcite (Stockmann et al. 2022). The groundwater acquires its high carbonate concentration from percolation from high elevations through the carbonatite bedrock of the Grønne-dal-Íka igneous complex, and seeps out in the fjord floor following existing faults and fractures. Ikaite precipitates around the outflows in chimney-like structures because the continuously supplied low-density ground water floats upwards. When exposed to higher temperatures (>6°C), ikaite breaks down to less hydrated forms of calcium carbonate minerals (Stockmann et al. 2022). The existence of the Ikka Fjord columns is therefore climate dependent, and they likely did not exist during previous warmer periods. A multibeam sonar mapping survey in 2019 (Seaman et al. 2022) revealed at least 938 columns, ranging in height from 0.5 to 20 m above the sea floor, restricted to a area in the inner Ikka Fjord. The multibeam mapping showed column clusters aligned with observed fault lineations (Seaman et al. 2022), supporting ground water outflow as a responsible mechanism. However, little is known about the sediments surrounding the columns, regarding thickness, stratigraphy, composition and distribution in the Ikka Fjord, which is crucial for our understanding of the ikaite column history and their fate under changing climate conditions.

Here, we present results from a sub-bottom profile survey performed in August 2021. We surveyed the entire Ikka Fjord with ~75 m line spacing (5 lines along and 24 across the fjord). The inner ~500 m of the fjord is occupied by coarse river sediments. Shallower areas are covered by <2 m soft sediments, and the ikaite column distribution shows no apparent relationship with sediment thickness. The deep (<29 m) inner basins show up to 13 m thick soft acoustically laminated sediments, whereas the outer deep basin only show ~5-7 m thick sediments without lamination. The thick sediment deposits are likely a result of fine grained siliciclastic material from the river mixed with organic matter from the rich biota encrusting the columns, which in turn trap sediment from transport to the outer fjord. In areas close to columns, the profiles show strong and irregular acoustic reflections in the sea floor (5-10 m bsf), which we interpret as carbonate layers. If correct, this indicates that columns have existed and broken down previously, likely in response to cold followed by warmer sea temperatures. The acoustic profiles will be used to find suitable sediment coring locations in the Ikka Fjord, in order to ground truth the sub-bottom profile interpretation and to study the sedimentary history in more detail.

## References

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