Mineral-trapping of greenhouse gases in arctic glendonites

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WHAT ARE GLENDONITES?

- Glendonites are fossil pseudomorphs of Ikaite, a hexa-hydrated form of CaCO₃.
- Glendonites are abundant in highlatitude (Arctic & Antarctic) sedimentary successions of Mesozoic and Cenozoic age \rightarrow Ikaite stable at low T



Glendonites show generally low Cisotope values (up to -50 per mille) and form in sea floor areas that show methane flux and oxidation coupled to sulfate reduction.

Left: Glendonite crystal from the Permian of Australia. Middle: Subrecent lendonite crystal in a pistone core taken in the Congo Fan (courtesy GeoMar). Right: Ikaite crystal dredged from sea floor in Disko Bugt (Western Greenland) in area showing methane seepage (Nielsen et al., 2014; GeoMarine Letters).



Glendonites from Jurassic and Cretaceous outcrops in Siberia and Svalbard contain large amounts of methane of thermogenic origin, suggestive of Type II gas hydrate dissociation. The hydrocarbon gases are present in the primordial calcite phase as small micro to nano-inclusions that also contain fluids. The high number of fluid inclusions hints at rapid transformation of ikaite into glendonite and trapping of fluids and methane and other greenhouse gases.



Glendonites trap GHGs for hundreds of millions of years. Can we use ikaite/ glendonite for CCS?

ONGOING & FUTURE RESEARCH

Lab based – We will perform precipitation ulletexperiments under controlled conditions making ikaite and study the transformation into glendonite. We intend to perform a wide range of analyses, including microbiological



Left: Fossilized ikaite (Paleocene) showing internal highly porous structure. Right: Synthetic ikaite transformed into amorphous calcite showing nanoporosity (Zhou et al., 2018; Analytical Chemistry).

and geochemical analyses.

- **Geological fieldwork** We will study ikaite • glendonite formation on different time scales (Holocene to Carboniferous) to understand links with paleoclimate, sea level, methane seepage and ash deposition.
- Oceanographic We intend to sample ikaite during research cruises from the Congo Fan and Disko Bugt (Greenland) in collaboration with the NIOZ.