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Better molecular preservation of organic matter in an oxic than a sulphidic depositional environment: evidence from modern and fossil dinoflagellate cysts

ABSTRACT

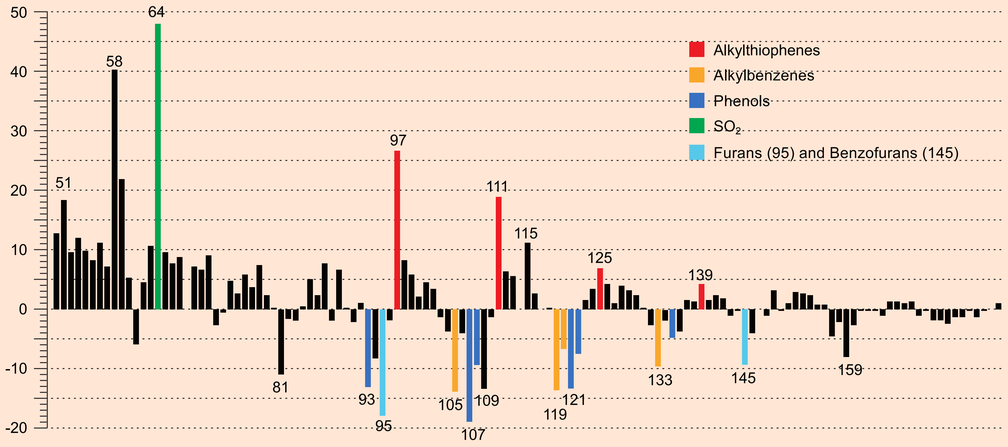
- In anaerobic sediments, abundant and labile organic matter (OM) providies many opportunities for its molecular modification and cross-linking. In oxic sediments labile OM is rapidly mineralized, and its transformative impact reduced. But, other, aerobic, transformative processes occur.
- To assess these different modes of molecular preservation we analysed fossil cysts of *Thalassiphora pelagica* (Dinophyta) from both the oxic Kerguelen plateau (40 Ma, Eocene) and the anoxic Rhine Graben (31 Ma, Oligocene) and compared these with unmodified cyst walls of cultured *Lingulodinium polyedrum* (Dinophyta) and the cell walls of cultured *Chlorella emersonii* (Chlorophyta).
- Despite unchanged morphology, molecular differences are strong. The cysts from the oxic environment still preserve a carbohydratic signature also in seen in the recent cysts. The cysts from the anoxic environment are strongly modified by a.o. natural vulcanization. Oxygen is lost and with it the carbohydrate signature. Aliphatic molecules have been added to the cyst walls.

METHODS

Clean cysts were hand picked from samples after removal of minerals with HCl and HF and analysed by:

- Fourier transform infrared of individual cysts,
- Pyrolysis GC-MS
- Thermally assisted hydrolysis and methylation GC-MS

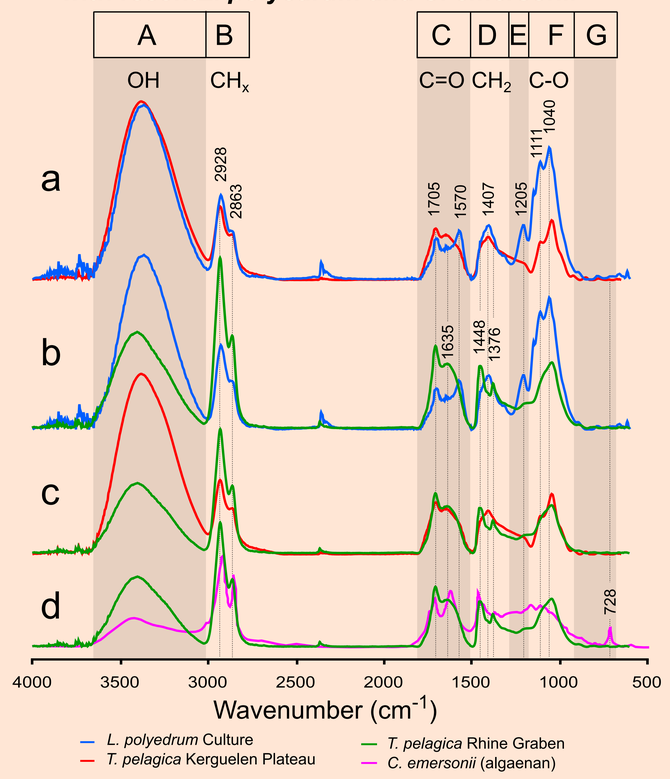
Pyrolysis GC-MS: *m/z* intensities *T. pelagica* Rhine Graben minus Kerguelen Plateau



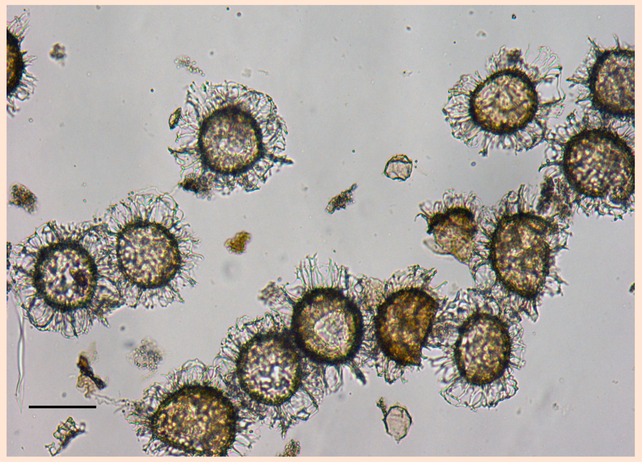
NB: possible *m/z* 58 fragments: C_3H_6O, C_4H_{10}, C_2S

Relative mass intensities of the total chromatograms (0-28 min) of Thalassiphora pelagica *from the Rhine Graben minus the Kerguelen Plateau (Versteegh et al., 2007). Masses with abundances < 0 are more abundant in the specimens from the Kerguelen Plateau. Note the masses indicating sulfur-containing fragments (thiophenes) are more important in the specimens from the Rhine Graben, whereas masses characterizing oxygen-containing fragments (furans, phenols) and alkylbenzenes are more abundant in specimens from the Kerguelen Plateau.*

FTIR analyses: comparison of fossil *T. pelagica* with recent*L. polyedrum* and *C. emersonii*



Micro-Fourier transform infrared ATR spectra of cultured Lingulodinium polyedrum *cysts (blue line), (remeasured sample of Versteegh et al. 2007);* Thalassiphora pelagica *cysts from the Kerguelen Plateau (red line) and the Rhine Graben (green line), (remeasured sample of Versteegh et al. 2007); and* Chlorella emersonii *(pink line) (adapted from Allard and Templier, 2000).*



Microphotograph of the Thalassiphora pelagica *assemblage from the Kerguelen Plateau prior to purification. Scale bar = 100 µm.*

CONCLUSIONS

- Excellent morphological preservation does not imply excellent chemical preservation.
- The initial biomacromolecule has been preserved better in the oxic environment.
- The best preservation of molecular structure is not necessarily where most OM gets preserved, which, is important for under standing the nature and fate of sedimentary OM and its isotopic signature.

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