Markers of sea-level change in estuarine sediments of Holocene age

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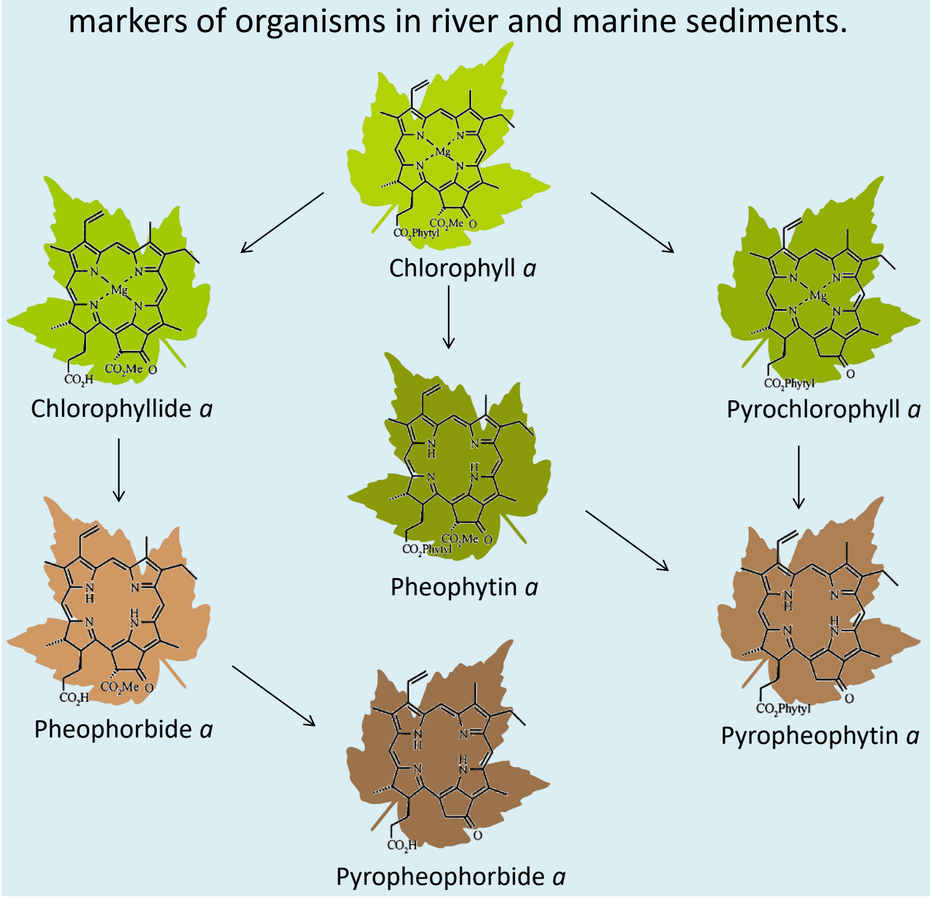
Introduction

- There are fluctuations in the rate of sea-level change during the Holocene epoch (last 11,700 years) across the British Isle.
- Pigments derived from the breakdown of chlorophylls are well represented in the sedimentary record as markers of organisms in river and marine sediments.



- The distribution of chlorophyll derivatives reflects the different organisms present at the time of sediment deposition, which contains environmental and climatic information such as changes in relative sea-level[1].
- Chlorophyll *a* undergoes several transformation reactions in the water column or in sediment (**see schematic**)[2].

Aim

Evaluate if there is a correlation and causation between the distribution of sedimentary pigments and sea-level changes recorded in the Thames Estuary sediments.

Methodology

Sampling
- 20 samples from Thames Estuary core provided by BGS

Sample preparation
- Freeze-dry
- Grinding and sieving

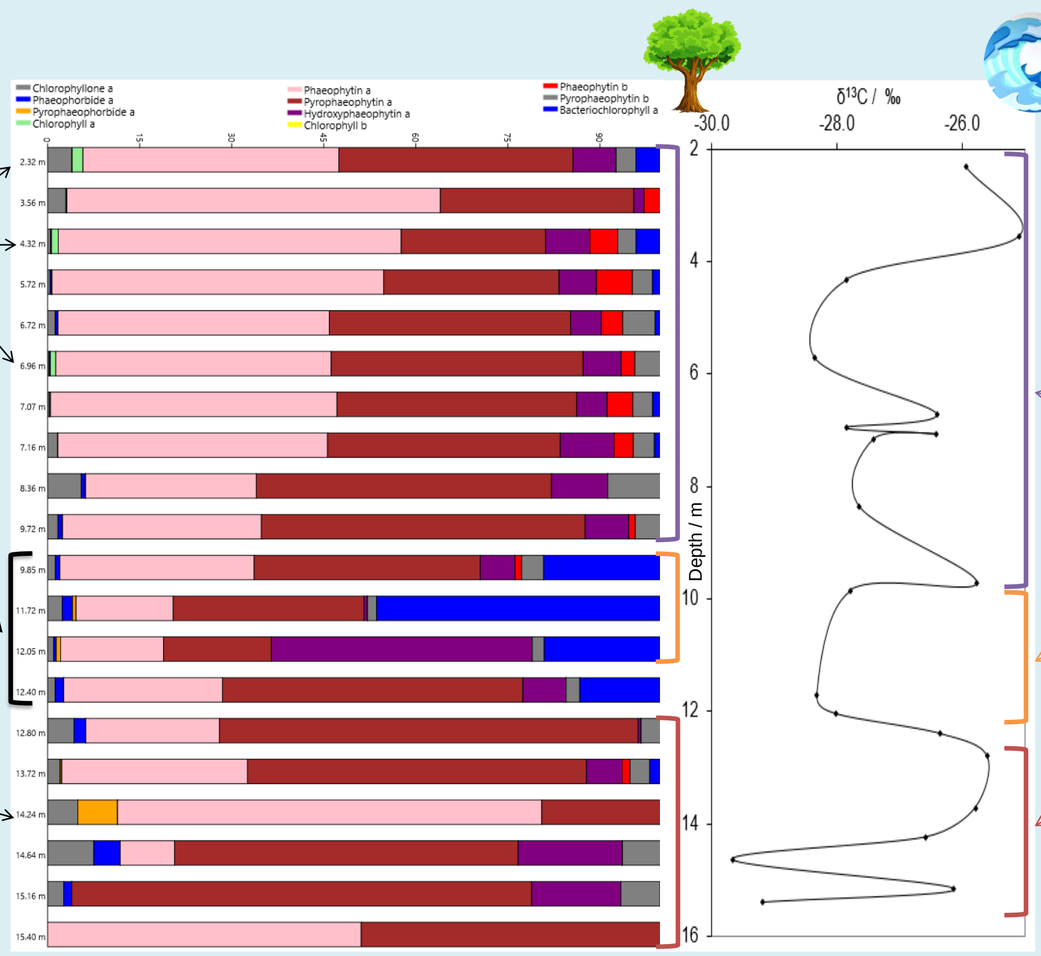
Extraction
- Accelerated Solvent Extraction (ASE)
- Dry
- Methylation with diazomethane

1 – 4 g of sediment
3 cycles
75 °C
Acetone solvent, 12 mL
25 minutes

Analysis
- Reverse-phase UHPLC-DAD[3]

Results and discussion

- Photosynthetic pigments were detected, confirming the sediments were contained in bodies of water. The pigment profile shows environmental changes.
- Chlorophyll *a* and *b* indicates shallower water column and less degradation.
- The lack of chlorophyll *a* and *b* further down the core demonstrates more degradation and a deeper water column.
- The presence of both bacteriochlorophyll *a*, occurring in anoxic waters[4], and hydroxypheophytin *a* implies stratification within the water column and the existence of a chemocline.
- The presence of pyrophorbide *a* suggests a deeper water column for chlorophyll *a* to undergo several transformation reactions.
- The presence of pheophytin *a* and pyropheophytin *a* throughout the core are indicative of algal communities. The bacterial growth is also prevalent in algal blooms.



- There are variations between terrestrial and marine carbon inputs throughout the core.
- The pigment profile shows similar abundances and compositions of pigments, indicating a stable environment. It does not seem to be affected by marine or terrestrial inputs.
- The organic carbon represents terrestrial sources. Pigments found here suggests there was aquatic freshwater input for algal production.
- The $\delta^{13}C$ data and pigment profile shows strong variations, (e.g. the appearance of pyropheophytin a), indicating an unstable environment.

Unstable environments generates lower concentration of pigments.

Stable environments generates higher concentration of pigments.

Conclusion

- The pigment profile and $\delta^{13}C$ data shows environmental variations.
- Some data from the pigment profile and $\delta^{13}C$ graph match at 9.85 m - 12.05 m and 12.80 m - 15.40 m, whilst some doesn't at 2.32 m – 9.72 m.
- Having multiple markers for sea-level change is more powerful than having one as it can reveal extra information that can change the meaning of the data.

Acknowledgements

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