

Biomarker Analyses of Saturated Hydrocarbons from the Newfoundland Basin- Implications for the Source of Organic Matter and Water Column Conditions across Oceanic Anoxic Event 2



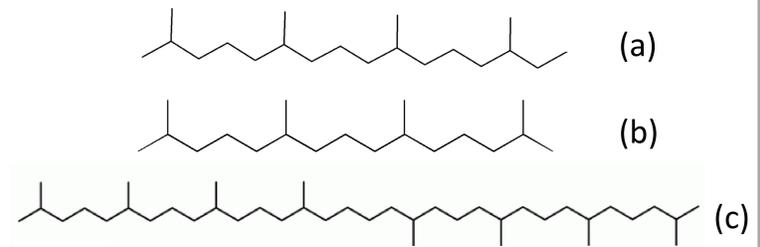
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Introduction

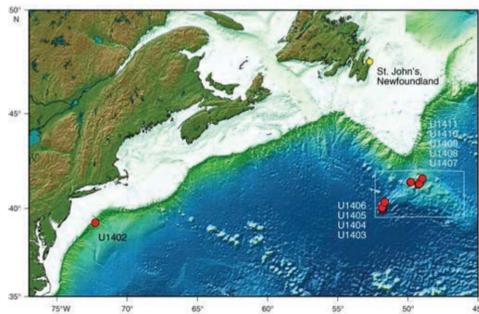
Petroleum biomarkers are the molecular fossilised remains of organisms. They can provide information about source rocks, including: a) the relative amounts of oil/gas prone organic matter (OM) in the source kerogen; b) environments of deposition; c) source rock lithology (if unknown); d) thermal maturity and e) relative ages. This study uses a group of saturated hydrocarbons, the *n*-alkanes, to determine information about the environmental conditions and source of OM to a basin off the coast of Newfoundland during an oceanic anoxic event (OAE) in the Late Cretaceous- OAE2. OAEs represent the Earth system response to extreme greenhouse conditions and climatic perturbations in the Cretaceous, characterised by the widespread deposition of black shale. OAE2 at the Cenomanian-Turonian boundary (~93.5 Ma) is linked to sluggish ocean overturning, global warming, LIP volcanism and the onset of anoxia and euxinia. The *n*-alkanes can provide insight to the ocean chemistry and environmental conditions of this period.



Structures of three isoprenoid biomarkers used in this study:
 a) Pristane b) Phytane and c) Lycopane
 (Peters and Moldowan, 2005).

Expedition 342- Drill Sites

Whiteside *et al.*, 2013



Operational area of 342. Red dots indicate drill sites. Holes U1407 A, B & C in white box contained sequences of OAE2 black shale

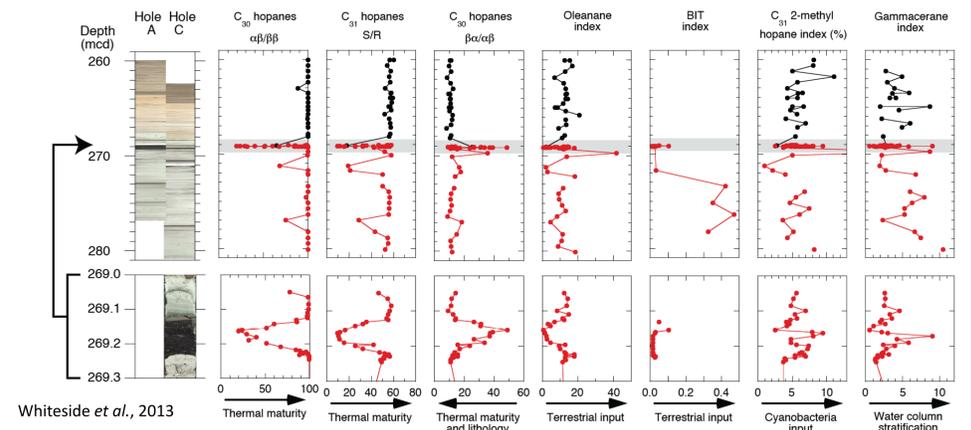
IODP Expedition 342, ~ 32° N palaeolatitude. Drill sites contained a biostratigraphically resolved OAE2 record from a pelagic setting



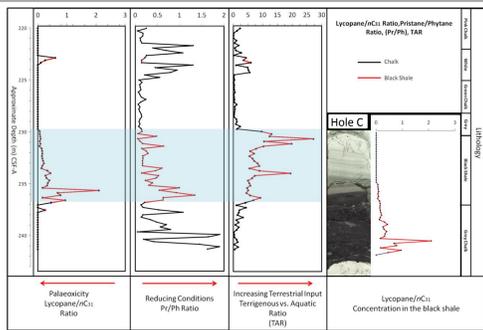
Plate kinematic reconstruction of the arrangement during deposition. The primary drill sites of Exp. 342 are marked by the yellow star

Motivation

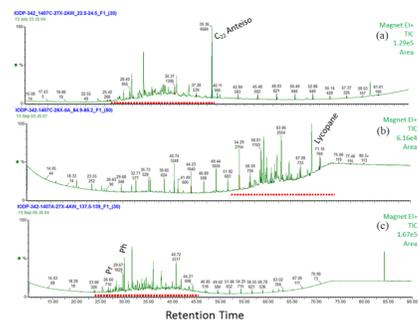
Initial biomarker results of Whiteside *et al.* (2013) from the aromatic hydrocarbon fraction of the black shale samples indicate a dominantly marine OM input to the basin during OAE2. However, the indices used to determine OM source here are prone to affects from other factors. The *n*-alkanes used in conjunction with these can provide more robust results.



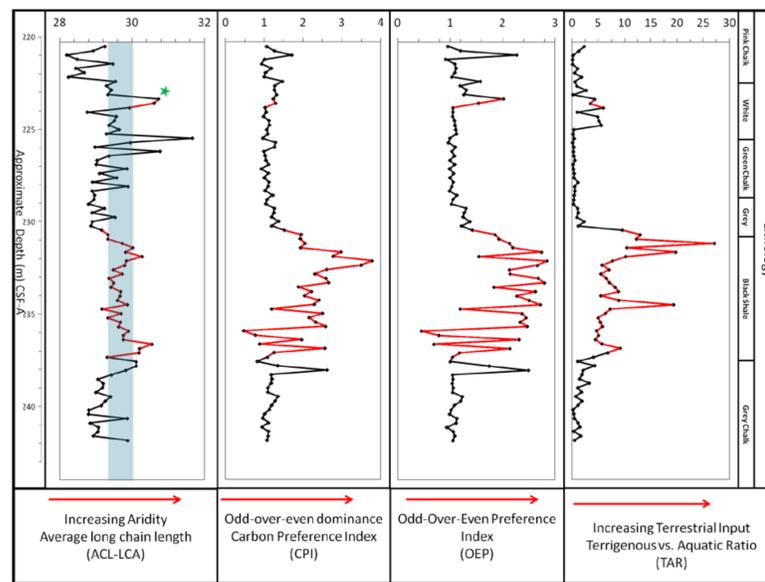
Whiteside *et al.*, 2013



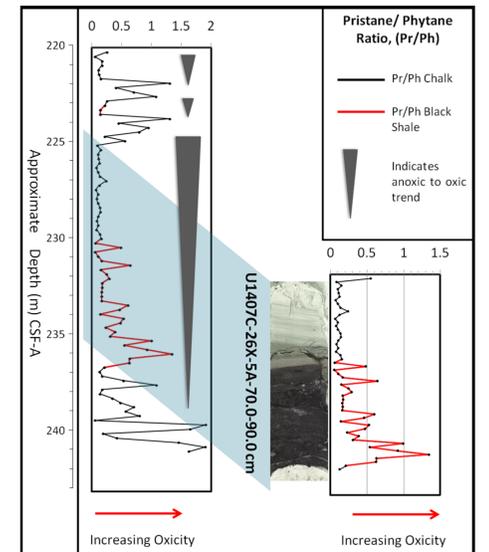
Lycopane for oxicity, above, with chemical conditions and OM input. Chromatograms below: a) post- b) during- and c) pre- OAE2.



n-alkane Biomarker Results



Carbon preference and chain lengths as source indicators



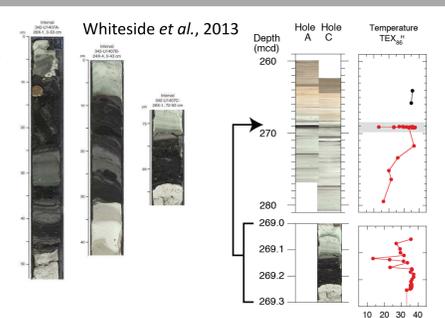
Pristane/Phytane Ratio indicating palaeo-oxicity

Conclusions

- n*-alkane carbon chain lengths analysed from holes U1407A and U1407C were present predominantly in the carbon number range *n*C15-*n*C40, with the greatest accumulations in the range *n*C25-*n*C35.
- Terrestrial input is at its highest during the deposition of the black shale interval at the heart of OAE2 where marine productivity is at its apparent lowest. The terrestrial signature is indicated by low values of SCA/LCA etc. This contradicts the biomarker results of Whiteside *et al.* (2013).
- ACL-LCA does not vary significantly, but is consistently slightly higher over the black shale horizon, potentially indicating slightly more arid conditions at temperature maxima, as indicated by the TEX₈₆ temperature data of Whiteside *et al.* and Sinnighe Damsté *et al.* (2010).
- Lycopane and the Pr/Ph ratio trend in agreement, indicating anoxic, reducing conditions, and support the biomarker results of Whiteside *et al.*, 2013, which indicate a stratified water column.
- Pristane and phytane appeared to be anomalously low in some samples, potentially indicating compound sulphurisation and euxinia.
- Aolian dust transport seems to be the most likely mechanism for the transportation of terrestrial higher plant waxes to the basin

Core images of black shale horizons in U1407 A, B and C respectively

- Greenish white nanocrystalline chert with foraminifers
- Pink foraminiferal nanocrystalline chert
- White nanocrystalline chert with foraminifers
- Grey nanocrystalline chert with foraminifers
- Zooclastic claystone with organic matter
- Claystone



TEX₈₆ SST data

Acknowledgements

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References

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