

BIOMARKERS FROM MARINE CRUDE OILS REFLECT MODELED CLIMATIC/OCEANOGRAPHIC CONDITIONS FOR THE LATE CRETACEOUS

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Preliminary results of our investigation of Late Cretaceous source rocks and oils with respect to Cenomanian/Turonian paleogeography, paleoclimatology, and paleoceanography show a clear correlation between environmental variables (upwelling, salinity, temperature and runoff) and the type and occurrence of source rocks and corresponding oils. There is a particularly strong association between regions of upwelling predicted by FOAM (Fast Ocean and Atmosphere Model) and the occurrence of oils with specific terpane distributions.

Holba *et al.* (2003) observed a relationship between oils derived from sources deposited in upwelling environments and the relative abundance of a number of extended tricyclic terpanes. A variation of this observation is illustrated in Figure 1. In this plot, the C26 S&R tricyclic terpane/C27 pentacyclic terpane Ts ratio (C26/Ts) is plotted as a function of the C24 tetracyclic terpane/C23 tricyclic terpane ratio (Tet/C23). High values of C26/Ts and low values of Tet/C23 are associated with oils derived from source rocks acknowledged to have been deposited in upwelling environments (e.g., the Miocene Monterey, Permian Phosphoria, UK La Luna Group, and Triassic Shublik). Marine source rocks deposited in epicontinental basinal settings and on marine shelves of semi-closed oceanic basins tend to generate oils with low values for the C26/Ts ratio, but higher values for the Tet/C23 ratio (e.g., the UJ of the Arabian Plate, Ordovician of the Williston and Michigan basins, and the UK Mowry-Cody of the Western Interior Seaway).

There is a positive correlation of zones of Late Cretaceous upwelling as predicted by the FOAM modelling with oils having large C26/Ts terpane ratio values such as the oils from the La Luna Group of northwestern South America. Oils classified as having been derived from sources deposited in “normal” marine environments have much lower values for C26/Ts and include the Late Cretaceous Tuscaloosa, Eagle Ford, and organic-rich shales deposited in the Late Cretaceous Western Interior Seaway. Some of these oils contain appreciable amounts of aryl isoprenoids, biomarkers for phototrophic, green sulfur bacteria. The environment in which these bacteria are viable is anoxic, within the photic zone, and H₂S-rich – euxinic conditions (Summons and Powell, 1987).

Putumayo, Oriente and Marañon basin oils have both elevated upwelling (C26/Ts) and high PZE parameters (aryl isoprenoids); modelled upwelling values are lower than might be expected from the trend of the biomarker data. This may partly result from the paleogeography of these basins. The aryl isoprenoid criterion (PZE) as an indicator of euxinic conditions is not clearly associated with specific depositional settings, but may signify episodic isolation of semi-enclosed basins from open marine environments. The occurrence of high PZE values may additionally be rationalized in terms of Cretaceous paleogeography. Periodic eustatic or tectonic interruption of water exchange between the Marañon, Oriente and Putumayo basins and normal marine environments may have promoted episodes of stagnation, and the evolution of euxinic conditions.

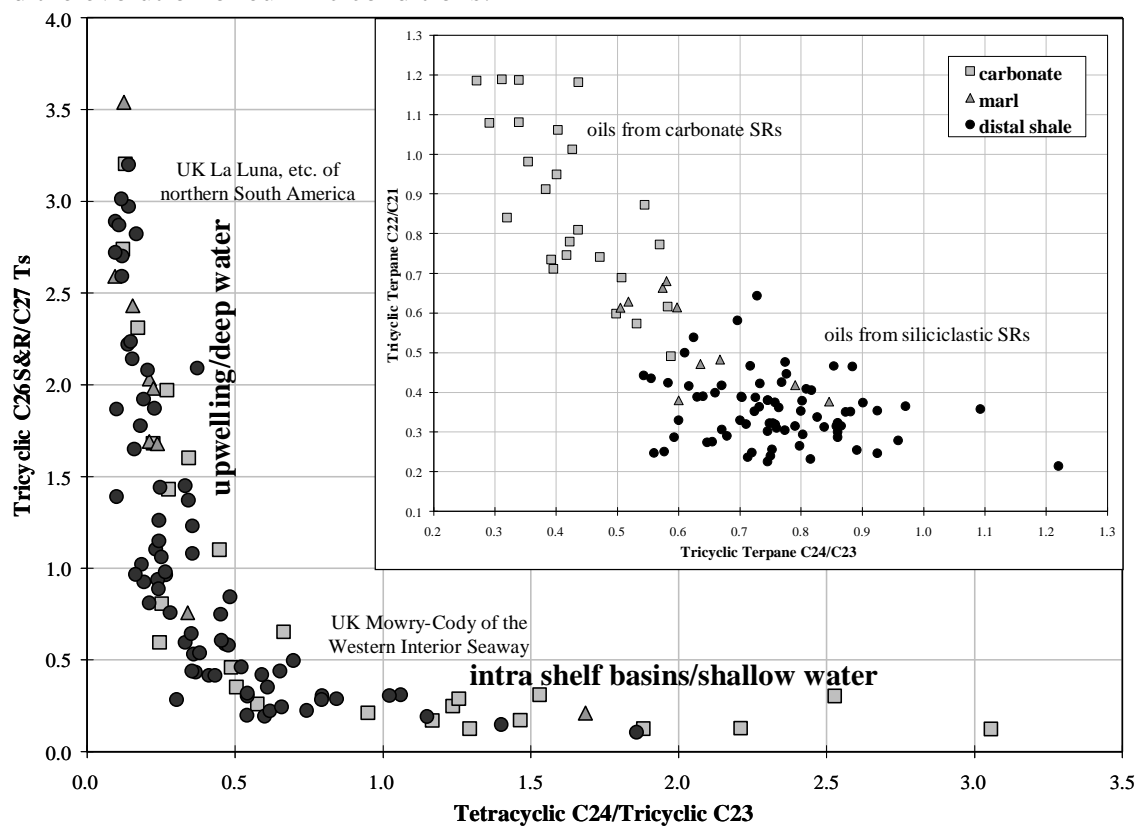


Figure 1. Marine crude oil terpane biomarkers predict source rock lithology and depositional environment regardless of geologic age; based on average values for global petroleum systems from GEOMARK'S OILS database (www.RFDbase.com).

REFERENCES

- Holba, A. G., J. E. Zumberge, B. J. Huizinga, H. Rosenstein, and L. I. Dzou, 2003, Extended tricyclic terpanes as indicators of marine upwelling; 21st International Meeting on Organic Geochemistry, Krakow, Book of Abstracts, p. 131.
- Summons R.E. and Powell, T.G. (1987) Identification of aryl isoprenoids in a source rock and crude oils: biological markers for the green sulfur bacteria. *Geochim. Cosmochim. Acta*, **51**, 557-566.