O71

CHANGES IN THE BULK AND COMPOUND-SPECIFIC STABLE ISOTOPES ($^{13}C/^{12}C$ AND D/H) OF WESTERN AUSTRALIAN CRUDE OILS THROUGH TIME

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This study focuses on the changes in the stable carbon ($\delta^{13}C$) isotopic composition of the saturated and aromatic hydrocarbons in western Australian crude oils through time. From this extensive dataset, carbon and hydrogen (δD) isotopic compositions of individual C_{7+} *n*-alkanes were obtained for the major genetic oil families. The samples originate from the Arafura, Bonaparte, Browse, Canning and Perth basins, with source ages that span the Cambrian to the Cretaceous. Complementary biomarker analyses provide insights into the type of organisms preserved in the source rock, its lithology and depositional environment, as documented by Geoscience Australia and GeoMark (2005).

This study shows that the line used to separate a global set of marine and non-marine oils by Sofer (1984), is not particularly useful for western Australian oils (Figure 1). Using the combination of bulk and *n*-alkane-specific $\delta^{13}C$ isotopic profiles, oil families of Palaeozoic and Mesozoic age can be distinguished. From the Early to the Late Palaeozoic, Australian oils have become isotopically more enriched in ^{13}C. The most depleted $\delta^{13}C$ value of -32.0 ‰ is recorded for the saturated hydrocarbon fraction ($\delta^{13}C$sat) of a Cambrian oil-stain in the Arafura Basin. $\delta^{13}C$sat values of about -31 ‰ are recorded for Ordovician oils from the Canning Basin, with slightly more enriched values (mean $\delta^{13}C$sat = -29.3 ‰) being obtained for Late Devonian marine oils in this basin. Early Carboniferous marine oils from the Bonaparte and Canning basins have mean $\delta^{13}C$sat values in the order of -28 ‰. Permian terrestrially sourced wet gases/condensates are some of the most ^{13}C-enriched samples from western Australian, with values of around -24.6 ‰ being recorded in the Bonaparte Basin and -25.7 ‰ in the Perth Basin. Early Triassic Perth Basin oils have extremely depleted saturated hydrocarbon isotopic values of around -32 ‰ that are not as pronounced in the aromatic hydrocarbon fraction (mean $\delta^{13}C$arom = -29.9 ‰), separating them from the Ordovician Canning Basin oils.

Jurassic oils from the Bonaparte, Browse and Carnarvon basins exhibit a range in their $\delta^{13}C$sat values from -26.1 to -27.8 ‰, due to generation from multiple source rocks

throughout the oil window. Their source rocks were deposited in fluvio-deltaic to marine systems and contain varying amounts of land-plant material. Early Cretaceous marine oils of the Bonaparte and Browse basins have depleted δ^{13}Csat values in the order of -30.2 ‰ and -28.6 ‰ respectively, and can be differentiated from the Early Carboniferous oils on their *n*-alkane-specific isotope profiles.

The *n*-alkane-specific δ^{13}C isotopic profiles of the Palaeozoic and Mesozoic oils and condensates characteristically follow the same trend as the bulk δ^{13}C isotopic values. The *n*-alkane-specific δD isotopic profiles typically complement those of the carbon isotopic profiles for the oils derived from marine source rocks. The carbon and hydrogen profiles exhibit distinct differences in oils that originate from either non-marine systems, or, in the case of the Triassic aged Perth Basin oils, a restricted anoxic marine environment.

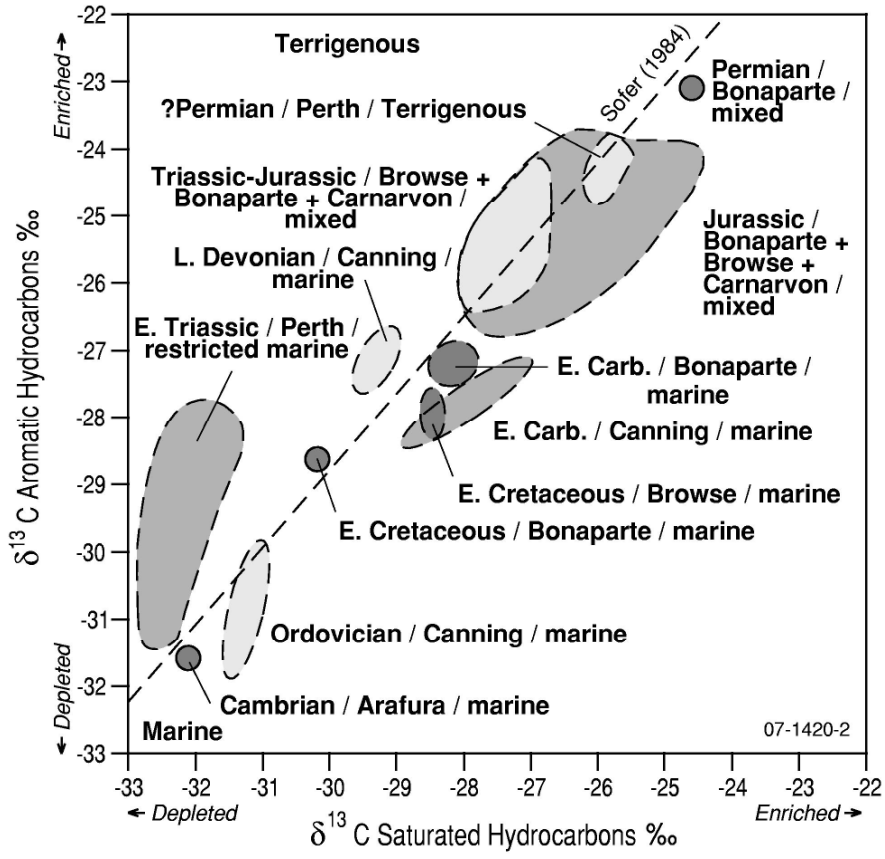

Figure 1. Stable carbon isotopic signatures of western Australian oils through time.

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