Quantitative biomarker abundances and 13C contents of saturate and aromatic fractions in six Indonesian oils are consistent with a parent source rock containing variable amounts of algal and terrestrial organic material deposited in a relatively oxic lacustrine environment. On the modified Sofer plot (Collister and Wavrek, 1996) these oils fall in the "non-stratified lacustrine and other marine" field. Quantitative abundances of terrestrial makers strongly covary with the 13C contents of the saturate fractions of the crude oils.

Examination of numerous molecular parameters, in conjunction with quantitative biomarker abundances, show that the samples can be divided into two groups that are thought to reflect the influence of organic matter input. The primary input of terrestrial organic matter (Group I oils) was diluted by organic matter from algal/bacterial sources (Group II oils). Interestingly, these groups coincide with significant variation in 13C contents of the oils. Because terrestrial organic matter can have dramatically different d13C values than algal/bacterial organic matter, variations in the percentage of these input sources might be reflected in the d13C values of the oils. To test this hypothesis, the isotopic composition of the saturated hydrocarbon fractions are plotted against molecular indicators of terrestrial input in (Fig. 1). A strong correlation is observed between the oleanane index and the d13Csaturates whereas the covariance is diminished for the C29/C27 sterane ratio vs. the d13Csaturates. This observation concurs with reports that the C29 steranes are likely to derive in part from algae, whereas higher plants are the only known precursor for oleanane. Numerous other terrestrial indicators also covary with the 13C contents of the saturate fractions. Collectively, these observations strongly suggest that the isotopic composition of the oils is controlled by the percentage of higher plant input vs. algal/bacterial input to the organic matter in the source facies. Thus, 13C enrichments in the saturate fractions of the Group II oils are consistent with increased aquatic primary production which served to swamp the isotopic signature carried by the terrestrial component.

Modern terrestrial lipids from C3 plants range from -30.1 to -38.7‰ (Collister et al., 1994) whereas the isotopic composition of modern algae can be highly variable depending on latitude, CO2 and HCO3- availability in the water column, and the isotopic compositions of these carbon sources. 13C contents of the CO2 in the water column can be strongly affected by stratification and the presence of a methane cycle. Thus, a priori, it is difficult to estimate the isotopic compositions of the aquatic primary producers, but since the isotopically enriched oils (ca. -22‰) contain relatively abundant terrestrial biomarkers, the algal population was likely to have
been heavier than -20‰. Varying amounts of such material superimposed on a background of 13C-depleted terrestrial material would account for the differences in the isotopic compositions of the oils and for quantitative variation in the abundance of terrigenous biomarkers. The results indicate the effective application of geochemical inversion and quantitative techniques to petroleum system analysis.

REFERENCES


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