APPLICATIONS OF COMPOUND SPECIFIC D/H ISOTOPES TO PETROLEUM AND SEDIMENTS

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Developments of compound specific isotope technology (CSIA) now include the capability of isotope mass spectrometers to successfully measure D/H of individual organic components in complex mixtures (such as petroleum and sediment extracts). The GC separated organic components are catalytically pyrolysed to H_2 and C by a chromium catalyst (100-200 um) at high temperature (1050ºC). The relative abundances of *m/z* 3 (DH) to *m/z* 2 (H_2) is determined in the isotope mass spectrometer relative to a H_2 gas standard of known D/H calibrated to an international isotope standard (Vienna Standard Mean Ocean Water). During the analyses corrections are made for H_{3+} (a product of by-product ion molecule collisions) which has an influence on *m/z* 3. The precision for D/H CSIA is 5 per mil.

Preliminary δD (and $\delta^{13}C$) of regular isoprenoids (pristane and phytane) and *n*-alkanes in a sedimentary sequence (Jurassic, NW Shelf) covering a large range of maturities from the top of the sequence to the bottom of the sequence have been obtained. The δD (and $\delta^{13}C$) show a correlation with depth (increasing thermal maturity) and vitrinite reflectance. For example, δD values change by more than 50 per mil whereas $\delta^{13}C$ values change only by 3 per mil covering a vitrinite reflectance range from 0.6 to 1.6 (covering the oil generation window). These results show the potential usefulness of δD and $\delta^{13}C$ of individual hydrocarbons in oils to assess their thermal history.

In another study, preliminary δD (and $\delta^{13}C$) results of *n*-alkanes in a number of Australian crude oils and condensates (Lower Permian to Upper Jurassic in age) from the Perth Basin (WA) appear to classify the oils into different groups based on age and source. The $\delta^{13}C$ values of *n*-alkanes in oils of Triassic age are significantly lighter (*cf*. Summons *et al.,* 1995) than the values for *n*-alkanes in oils of Permian age. Therefore $\delta^{13}C$ signatures of the Perth Basin oils appear to correlate with their assigned ages, and are consistent with the theory that a global climate event occurred at the Permian/Triassic boundary (e.g. Knoll *et al.,* 1996). δD values for a series of *n*-alkanes in one of the Jurassic oils are significantly lighter than the *n*-alkanes in other oils of the same age by about 60 per to 70 per mil and indicates this oil is from a lacustrine (with high rates of precipitation) rather than a marine source. In many cases the δD values for isoprenoids are less depleted in D than the δD values of *n*-alkanes in the same samples. Previous studies on extant organisms have indicated that the polyisprenoid lipids biosynthesised are significantly lighter in D compared to *n*-alkyl lipids (Sessions *et al.,* 1999). However petroleum hydrocarbons are formed through many processes in the subsurface, and the effect of these processes needs to be further investigated as significant D/H exchange is likely to have occurred.

The preliminary results obtained in both these studies indicate the potential applications of D/H by CSIA in petroleum geochemistry.

References

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