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13C/12C Isotope Fractionation Accompanying Biodegradation of Hydrocarbons in A Natural Laboratory: Implications for Source Identification

Considerable interests for 13C/12C isotope fractionation involving aerobic/or anaerobic biodegradation of organic compounds have been increased due to its great applications for source identification and intrinsic bioremediation in environmental science. This paper aims to determine the magnitude and direction of transformation of stable carbon isotopes during microbial degradation of hydrocarbons which collected from several oil reservoirs with well-known identical source and maturity in Liaohe Basin, Northwestern China. The results show that biodegradation has had little effects on the whole oil and aromatic hydrocarbons, and a sequential loss of n-alkanes leads to slight isotopic depletion in the aliphatic hydrocarbons. Macromolecular organic matter (resins, asphaltenes) from severe biodegraded oils are 13C-enrichment relative to that of unaltered oils (up to 1.5~2.0°ë). Stable carbon isotopic composition of individual n-alkanes demonstrates that 13C values of n-alkanes with greater than 20 carbon atoms vary only slightly (within analytical uncertainty 0.5°ë). However, there are dramatic changes in the isotopic compositions of low molecular weight n-alkanes (nC13-nC20), which expressed as an increase 13C value relative to that of unaltered oils (up to 3~4°ë). In contrast, the acyclic isoprenoids (C15-C20) become progressively 13C depleted with the increasing biodegradation, the changes are up to 58’. The results suggest that the lower molecular weight hydrocarbons can be used to monitor in-situ bioremediation of crude oil contamination, and the conservative character of 13C concentrations for high molecular weight n-alkanes indicates that these compounds are effective tracers for oil/source identification in biodegraded reservoirs and oil-polluted environments.