Anaerobic degradation of aromatic hydrocarbons as monitored by $^{13}C/^{12}C$ stable isotope fractionation and specific metabolites

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$^{13}C/^{12}C$ and D/H stable isotope fractionation and metabolite analysis were used to assess anaerobic biodegradation of aromatic hydrocarbons in contaminated aquifers.

Detection of specific metabolites for anaerobic degradation of aromatic hydrocarbons proved that PAH and BTEX were degraded under anoxic conditions in a contaminated aquifer. This was also the basis to choose isotope fractionation factors specific for anaerobic degradation of aromatic hydrocarbons to assess the degradation on the site quantitatively. A transect of groundwater wells was monitored along the main direction of the groundwater flow and revealed decreasing concentrations accompanied with an increase in the $^{13}C/^{12}C$ stable carbon isotope ratio of the residual hydrocarbons. Calculation of the extent of biodegradation based on the isotope values and laboratory derived isotope fractionation factors showed that the residual substrate fraction was degraded up to 99 % by microbial activity. Calculation of the theoretical residual concentrations based on the measured isotope values described the strongly decreasing concentrations along the plume. Our results show that analysis of stable isotope fractionation and the detection of specific metabolites offers two lines of evidence for anaerobic degradation in the field and allows to choose the appropriate fractionation fators for stable isotope analysis.

Os isotopes, Deep-rooted mantle plumes and the timing of inner core formation

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Formation of the inner core has implications for the evolution of Earth’s magnetic field. The origin of deep-rooted mantle plumes has implications for our understanding of mantle dynamics. Traditionally, attempts by geophysicists to elucidate these important issues have incorporated seismological observations and global heat transfer models. Os isotope geochemistry now adds important evidence to the debate. Brandon *et al.* have argued that coupled enrichments in ^{186}Os and ^{187}Os in the relatively young, deep-rooted Hawai’ian and Noril’sk plume-derived lavas are a signature of the outer core, where radiogenic Os isotopic compositions have developed as a result of early fractionation of Os from Re and Pt during crystallization of the inner core. Meibom and Frei found that Os-rich PGE grains derived from peridotite bodies in NW California and SW Oregon also have very radiogenic $^{186}Os/^{188}Os$ and old Re-Os minimum ages, from 256 to 2644 My. If these Os isotopic compositions are a signature of the outer core, the inner core must have formed within several hundred million years after accretion of the Earth; in disagreement with results of geophysical modelling, according to which the inner core started forming no earlier than 3 Ga. The Os isotope data therefore addresses the important issues of timing of inner core formation and the origin of deep rooted plumes. If mantle plumes can originate at the core-mantle boundary the Os isotopic signal in the Hawai’ian lavas is likely to be an outer core signature and the inner core to have formed early. If the inner core formed late the radiogenic Os isotopic compositions are likely not an outer core signature, and geochemical evidence for plumes originating at the core-mantle boundary disappears. New data on Os-rich PGE grains will be presented.

References

Brandon A. *et al.* (1998) *Science* **280**, 1570-1573.
Meibom A. and Frei R. (2002) *Science* **296**, 516-518.