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## **LEAD ISOTOPE RATIOS IN HYDROCARBONS: A NEW APPROACH TO AGE DATING CRUDE OILS AND ENVIRONMENTAL RELEASES OF REFINED PETROLEUM HYDROCARBON PRODUCTS**

Chronologic methods for determining the geologic age of a crude oil or estimating the year a refined hydrocarbon product, such as gasoline, was released into the environment has been a difficult task. This work presents an overview of an approach in which high precision stable lead isotope analyses are utilized either independently or with high resolution gas chromatography to provide chronologic information. Environmental applications of lead isotope ratio analyses to estimate the year refined petroleum hydrocarbons were released into the environment and/or correlate accidental releases to their source are referred to collectively as the ALAS Model (Anthropogenic Lead ArchaeoStratigraphy; Hurst, 2000, 2002).

**Geologic Age of Crude Oils:** Lead isotope ratios (e.g.  $^{206}\text{Pb}/^{207}\text{Pb}$ ,  $^{206}\text{Pb}/^{204}\text{Pb}$ ) of Alaskan North Slope kerogens and genetically-related crude oils overlap, demonstrating the conservative transfer of these ratios from kerogen to crude oil during catagenesis. Furthermore, lead isotope ratios of Phanerozoic crude oils (Devonian to Tertiary) are observed to follow average crustal lead isotopic growth curves, indicating the potential of lead isotopes as a means of age dating and correlating crude oils.

**Petroleum Hydrocarbon Releases:** The knowledge that lead forms bonds with alkyl and other functional groups in hydrocarbons has added another dimension to lead isotope analyses as applied to petroleum hydrocarbon releases. Statistical correlations between organic compound and lead isotope ratios will be discussed using case studies at sites involving the attenuation of MTBE in groundwater, the correlation of a diesel release to its source, and the estimation of the years gasoline was released from a service station.

Although the original application of hydrocarbon lead isotope analyses and resultant ALAS Model focused on estimating the year leaded gasoline was released into the environment, ongoing refinements involving lead isotope-organic correlations continue to enhance the method's utility in a variety of petroleum hydrocarbon investigations.