



## Engineering Sciences Section – 2007

### C27 The Emergence of Stable Isotopes in Environmental and Forensic Geochemistry

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After attending this presentation, attendees will understand how stable isotopes have become an important topic in many issues of environmental forensics and other related areas of forensic science.

This presentation will impact the forensic community and/or humanity by demonstrating how stable isotopes are becoming an important tool in environmental forensics. They are being used not only in environmental forensics but related topics in food science, drug abuse, arson investigations, and many other areas. This presentation will provide an overview on why this approach has become so important and how one obtains the data.

The development and commercial availability of combined gas chromatograph-isotope ratio mass spectrometer (GCIRMS) systems that permit the determination of the isotopic composition of individual compounds has lead to a significant increase in the use of this approach in environmental forensic studies. This paper will provide an overview of this approach and use several examples to demonstrate the utilization of the approach to a variety of forensic and environmental problems. The examples will illustrate the use of stable carbon and hydrogen isotopes in the determination the origin of refined hydrocarbons and other organic carbon compounds in the environment. Wherever possible the isotope fingerprints are combined with data from GC and GCMS and other evidence. However in certain cases, when looking at individual spills, such as toluene for example, stable isotopes can be used to discriminate toluene derived from different feedstock. Products such as gasoline, even if heavily weathered through evaporation, will still maintain their original isotopic signature in the weathered residue. In this manner even though the GC fingerprints of a suspected source and product in the environment will look very different, the isotopic composition of individual compounds in the two samples will still be able to show whether the samples are related or not. Engine oil samples from hit and run accident victims would be another application whereby it would be possible to relate oil spots on the victim with oil samples taken from the suspected vehicle through a combination of the isotopes and GC and GCMS. From an environmental perspective it is often necessary to determine whether a particular compound has been undergoing biodegradation as a result of natural attenuation. It is often very difficult to do this on the basis of concentration data since a decrease in concentration may simply represent a dilution effect. However, the authors' work with compounds such as MTBE and various BTEX compounds clearly show that a decrease in concentration accompanied by an isotopic enrichment for both carbon and hydrogen is overwhelming evidence for the onset of natural attenuation. The source and fate of chlorinated solvents such as PCE, and TCE along with perchlorates compounds in the environment is an area where chlorine isotopes are starting to play an ever-increasing role in the same manner. Examples of the use of stable isotopes to discriminate several sources of PCE/TCE at an industrial site will be discussed.

In addition to the topics mentioned above stable isotopes play an important role in the food and liquor industry. For example in tequila isotopes can be used to determine whether the tequila has been adulterated from cane sugar rather than agave. Are all spices sold natural or do some contain synthetic compounds? Again isotopes play a key role in this type of study. Isotopes can be used to determine geographic source areas for drugs such cocaine. Isotopic differences between synthetic testosterone and natural testosterone for example can play an important role in doping controversies. Arson investigations can also benefit from use of isotopes since accelerant residues can be correlated to the original product used to start the fire. Bulk carbon and nitrogen isotopes have also been used to determine the geographic origin of certain drugs.

The number of applications of isotopes to these types of problems is limited only by the level of one's imagination. Applications are in their infancy and will continue to grow with additional isotopes being utilized in the future at ever decreasing levels of detection.

#### **Stable Isotopes, Environmental, Forensics**