C39 Forensic and Environmental Applications of Stable Carbon, Hydrogen, and Chlorine Isotopic Composition of Individual Compounds

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After attending this presentation, attendees will learn what is meant by a stable isotope; the areas related to forensic science where stable isotopes may be used to solve problems; levels of detection currently available; future developments, and other isotopes that will used in future studies.

This presentation will impact the forensic community and/or humanity by demonstrating the use of stable isotopes in forensic problems.

Utilization of stable isotopes, such as carbon, hydrogen, and chlorine, in a variety of forensic and environmental applications has seen a significant increase in popularity in recent years. The primary reason for this has been the development of combined gas chromatograph-isotope ratio mass spectrometer (GCIRMS) systems that permit the determination of the isotopic composition of individual compounds without the need for isolation of the individual compounds. It is the purpose of this paper to provide a brief overview of this relatively new technique and then to provide examples of the utilization of the approach in a variety of forensic and environmental problems. A number of the examples will illustrate the use of stable carbon and hydrogen isotopes for the purposes of determining the origin of refined hydrocarbons and other organic carbon compounds in the environment. Wherever possible these fingerprints are combined with data from GC and GCMS and other evidence. However in certain cases, when looking at individual spills such as toluene, stable isotopes will discriminate toluene derived from different feedstocks. Products such as gasoline, even if heavily weathered through evaporation; will still maintain the 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 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.

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.

In brief, 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.

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