

Stable Isotope Forensics

- Identification and comparison of unknown samples of legal interest
 - Food products, drugs, explosives, unknown individuals etc.
- Random match probability of 1:10,000 to 1:1 million

What's an isotope??

- Same number of protons and electrons, different number of neutrons
 - Differ in mass, so heavier isotope moves more slowly in chemical reaction
 - Differing ratios of two isotopes of same element in different materials
- Stable isotopes do not decay
- Delta (δ) notation, in units permil‰
- Commonly used: $\delta^{15}\text{N}$, $\delta^{13}\text{C}$, $\delta^2\text{H}$, $\delta^{18}\text{O}$,

Food Products

- Authenticate food products
- Single seed oils
 - Corn, olive etc
- Beverages
 - Carbonated water
 - Wine



Illegal Drugs

- Marijuana
 - Brazil: $\delta^{15}\text{N}$, $\delta^{13}\text{C}$
 - U.S.: $\delta^2\text{H}$
- Morphine and Heroin
- Cocaine: $\delta^{15}\text{N}$, $\delta^{13}\text{C}$



Synthetic Drugs

- Amphetamines
 - Ecstasy
 - $\delta^{15}\text{N}$, $\delta^{13}\text{C}$, $\delta^2\text{H}$
 - Match tablets to batch
 - Inferences made but not conclusive on their own



Explosives



- Naturally occurring variation hampers conclusions
- Ammonium nitrate- ANFO
 - $\delta^{18}\text{O}$, $\delta^{15}\text{N}$, $\delta^2\text{H}$,
- Peroxide explosives
 - Triacetone triperoxide (TATP)
 - Hydrogen peroxide precursor
- RDX and Hexamine precursor



Arson: Matching Matches

- Matchsticks at fire scene to seized matchsticks
 - $\delta^{13}\text{C}$, $\delta^{18}\text{O}$, $\delta^2\text{H}$
- Burnt matchsticks too!



Unknown Individuals

- Complement forensic anthropologist's biological profile
 - Diet, geographic origin- geographic lifehistory
 - Hair, nails, bones and teeth
 - Carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$)- diet
 - Hydrogen ($\delta^2\text{H}$) and oxygen ($\delta^{18}\text{O}$)- water sources

Case studies

- U.K.- determine where deceased lived prior to death and time since entrance to UK
 - Hair samples: moved 3 times in 15 months
 - 2.5-3 months in Eastern Europe
 - 6-7 months in Germany or Czech Republic
 - Last few months on west coast of U.K.
 - Able to track his movements, confirmed isotopic findings

Case studies contd.

- Dublin, Ireland: unknown individual
 - Dismembered and mutilated
 - Hair, nails and bone (femur) sample
 - Non-local diet
 - Oxygen ratios rare- 5 regions fit
 - In Dublin for ~6 months
 - Used to match to individual and get DNA from relatives
 - Kenyan man who moved to Dublin 7 years prior to death

Conclusions

- New applications, new science
- Still being explored
- Use several elements in conjunction with other lines of evidence
- Great potential for future

For more information:

- Meier-Augenstein, Wolfram. (2010). Stable Isotope Forensics. Hoboken, NJ: Wiley-Blackwell.
- Forensic Isotope Ratio Mass Spectrometry (FIRMS) Network
- Major Labs in the US:
 - FBI's Stable Isotope Forensic Laboratory at the Counterterrorism and Forensic Science Research Unit
 - Chemical Science Division at the Oak Ridge National Laboratory
