

## Introduction

- Chemical elements consumed as food and drink become incorporated into body tissue.
- These elements have naturally occurring different forms called isotopes, with distinct differences in isotopic abundance of a given compound being indicative of differences in dietary habits and / or geographic origin.
- There is a relationship between isotopic composition of human tissue and geographic location, which can be exploited forensically to aid in human provenancing.

Fig. 1: Stable Isotope Man

## Background

Isotopically speaking "you are what you eat and drink, and where you eat and drink ( $\pm$  a few ‰)". For example, a seminal experiment<sup>1</sup> concluded that at least 30% of the hydrogen bound in human hair (keratin) is directly derived from water. Similarly all food and drink we consume and the elements contained therein contribute to the isotopic make-up of fingerprint of human tissue (Fig. 1).

Longitudinal studies showed influence of potentially compounding factors (e.g. globally sourced food) to be not greater than inter- and intra-individual variability of isotope signals in human hair and nails.

## Research into Relation between SIPs, Diet and Geographic Location

- A significant relationship between the SIP of an individuals hair and nails and their geographic location has been found (see Fig. 3).<sup>3,4</sup>
- An longitudinal investigation to understand the natural background fluctuations of individuals SIPs when static in one geographic location for 9 months to one year has been carried out.<sup>3</sup>
- Studies substituting isotopically labelled water for water used as drinking water and for preparing beverages and cooking food are currently underway to determine amount, turnover rate and isotopic effects of hydrogen incorporation into hair and nails.



Fig. 4: Sample of scalp hair submitted for forensic stable isotope analysis.

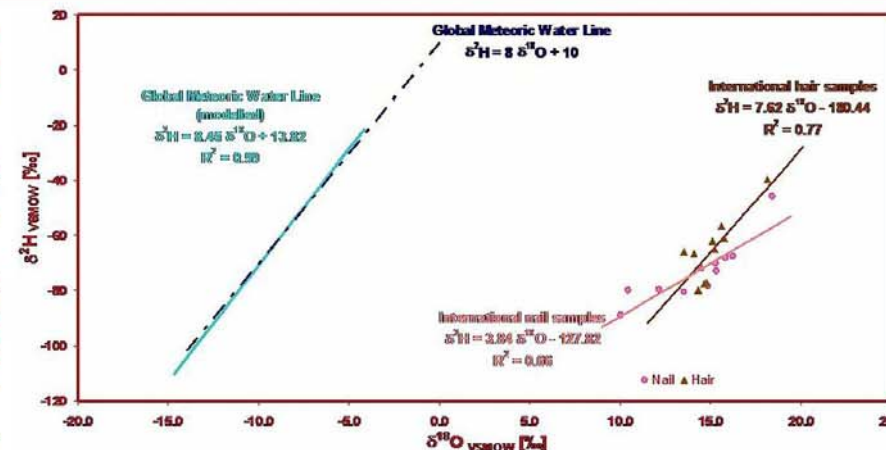


Fig. 3: Correlation plot of  $\delta^2\text{H}$  and  $\delta^{18}\text{O}$  values from globally sourced hair and nail samples in relation to the Global Meteoric Water Line (GMWL).<sup>3</sup>

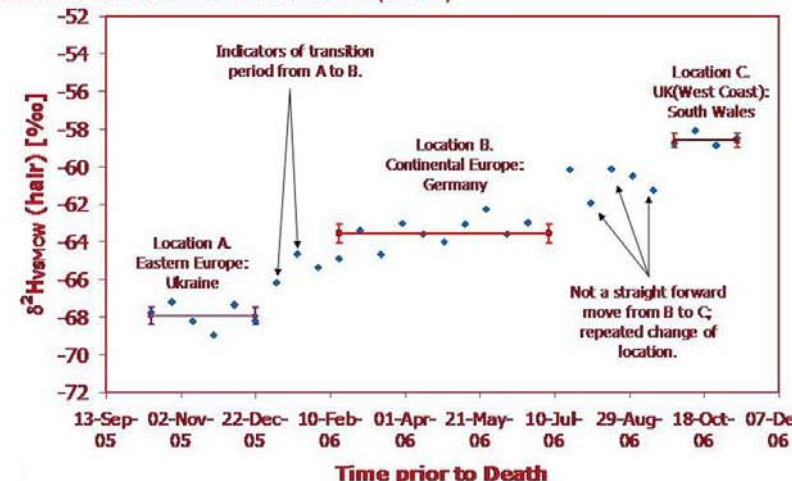


Fig. 5: History of geographic movement over a period of 15 months prior to the victim's murder showing residence in 3 distinctly different locations.

## Successful Application of SIP to Human Provenancing

Our lab has already successfully aided Police Forces in many investigations. In a recent enquiry, a 15 month geographic history was established for a murder victim suspected to have entered the UK illegally. A hair sample taken from the victim's scalp (Fig. 4) was divided into 5 mm segments with each segment representing a time frame of two weeks.

Figure 5 shows measured  $^2\text{H}$  isotope data plotted against time. The data clearly show residence in three different location prior to death. The locations identified by our work were later confirmed by further police investigations involving Interpol and the German police.

Apart from globally sourced food, a compounding influence from drinking bottled water is a frequently uttered criticism when stable isotope work is being presented. Results from our own (financially limited) research into this potential problem show the isotope signature of locally best selling bottled waters to be very similar to that of local tap water (Fig. 2). This finding (though from a small sample set) is in very good agreement with results of large scale study on isotopic composition of bottled water by Bowen *et al.*<sup>2</sup>

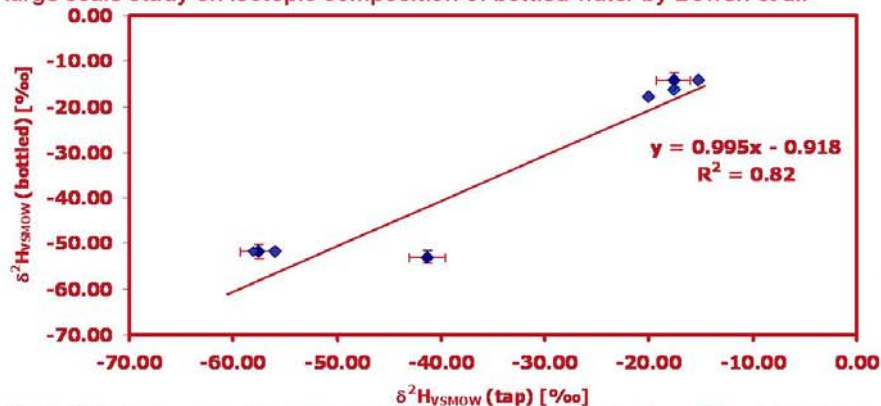


Fig. 2:  $^2\text{H}$  isotopic composition of bottled water versus local tap water from different locations.