Isotope Analysis of Safety Matches

Background

Isotope ratio mass spectrometry (IRMS) has been used to identify whether individual safety matches can be matched to their original box or manufacturer. To the best of our knowledge, this is the first time safety matches have been analysed using this particular technique..

The work was undertaken as an unexploited area of analysis was identified, when items were collected from a crime scene with no method for comparative analysis. Burnt and unburnt matches can be found at a scene of crime – typically in cases of arson or self-immolation. It is proposed that matches seized from suspect can be compared to those from the scene, with the use of appropriate comparisons and controls.

Safety matches are commonly made from Aspen (*populus tremula)*. Most matches produced for sale in the UK are produced from managed forests in Sweden, although other sites of manufacture have been identified, each with a managed forest or plantation nearby to keep the factory in a constant supply of logs (as shown below in Fig. 1). As such, the work was extended to include matches from around the world to determine if these could be distinguished.

The proposed sequence of analyses (conducted separately for scene, controls, suspect matches) is as follows:

Heads removed into vials by scalpel, and retained.

The remaining wood splint is dried, ground and prepared for isotopic analysis (IRMS). Isotopic compositions are determined, expressed as $\delta^{13}C$ and $\delta^{2}H$ values and compared.

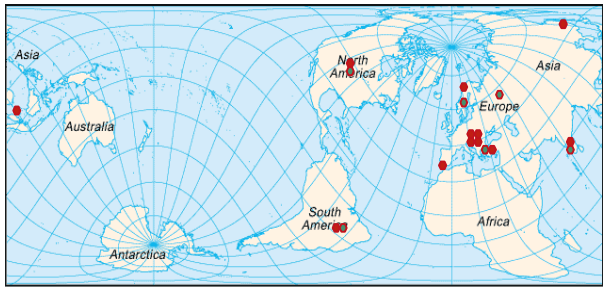

Figure 1 shows the sites of match manufacture, worldwide , and also the published sites of managed forests and plantations, from which the wood is sourced

Results

Three matches per box were analysed to determine variability in $\delta^{13}C$ data. First results were very encouraging (Fig. 2), with relatively small variation observed in one box.

Variability was then tested between batches and it became apparent that large variability exists within one box (Fig. 3). Results obtained for matches from 'Swan Vesta A' are a particularly striking example.

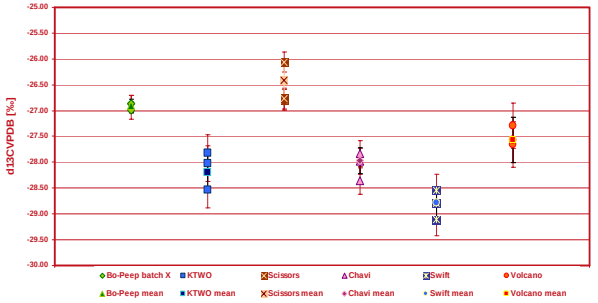

Figure 2: $\delta^{13}C$-Values from five brands of matches: BoPeep, KTwo and Swift, sold in UK, made in EU. Scissors, bought in UK, made in Czech Republic. Chavi, sold and made in India. Volcano, sold in Jamaica, made in India.

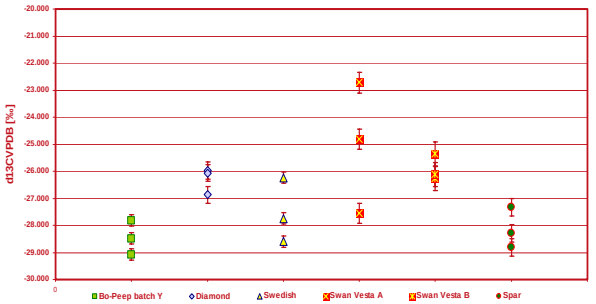

Figure 3: $\delta^{13}C$-Values from four further brands, including batch variation. Bopeep, Swedish, and Swan Vesta all made in the EU. Spar matches are made in the Czech Republic while Diamond matches are made and sold in the USA.

Both $\delta^{18}O$ and $\delta^{2}H$ values were measured to aid further discrimination of samples. Preliminary data indicate that using $\delta^{13}C$ and $\delta^{2}H$ values in combination helps to discriminate samples (Fig. 4), and can aid in identification of the country of manufacture.

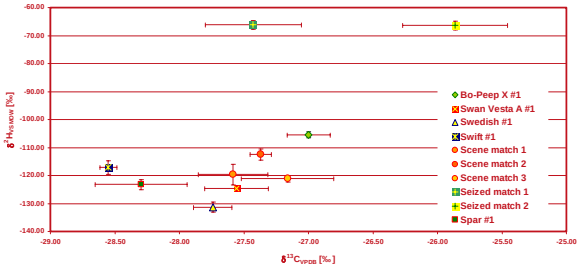

Figure 4: $\delta^{13}C$ and $\delta^{2}H$ values for five boxes of matches sold in the UK, as well as for samples seized and submitted for forensic analysis.

The Case

Samples were submitted for isotope analysis by the Police Service Northern Ireland (PSNI), with the aim of comparing matches found at a crime scene (scene match 1 and 2), with those seized from a suspect (seized match 1 and 2) . Matches from the UK were analysed for ^{13}C and ^{2}H isotopic composition, and compared to those submitted with surprising results (Fig. 3).

Matches from the UK and from the crime scene showed $\delta^{2}H$ values in the range of -100 to -130 ‰. The seized matches differ from these greatly, having $\delta^{2}H$ values of -65 ‰ (Fig. 3).

These differences can be accounted for by geographical differences of ^{2}H isotopic abundance in ground water and precipitation. The above data indicate that matches collected at the crime scene and matches seized came form two different sources. We surmise that the seized matches were produced in India.

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References:
Figure One reproduced "Courtesy of the University of Texas Libraries, The University of Texas at Austin."

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