B159 Predicting the Origin of Heroin by Analysis of Inorganic Elements and Isotope Ratios of Strontium (Sr)

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The goal of this presentation is to inform attendees regarding the efforts to profile heroin by means of inorganic trace element compositions as well as Sr isotope ratios 87Sr/86Sr.

This presentation will impact the forensic science community by demonstrating the potential for heroin sample matching and origin determination by examination of radiogenic Sr isotope ratios and trace elemental composition and the potential for this application to other forensic matrices.

The effort to understand the dynamic nature of drug production and distribution has lead intelligence and forensic experts to increasingly rely on analytical chemistry for solutions. In an attempt to aid assignment of origin to seized shipments, heroin samples of known provenance have been dissolved by microwave-assisted acid digestion and studied by three varieties of Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) for elemental composition and isotopic ratios $^{87}Sr/^{86}Sr$ whenever possible. For the elemental analysis of heroin, inorganic composition was quantitatively determined by quadrupole ICP/MS and high-resolution ICP/MS. For the precise measurement isotope ratios of strontium, samples were prepared by affinity resin chromatography and analyzed by multi-collector ICP/MS. To predict a provenance assignment, the results of the analysis have been analyzed by single-variable and multivariate statistical analysis. This is the first large-scale study with 40+ samples from each of the major source regions to investigate provenance determination through inorganic trace element composition and radiogenic strontium isotope ratio analysis.

The utility of light-element, stable isotopic ratio values has been investigated in heroin for provenance studies.[1-3] Geochemical studies have demonstrated that $^{87}Sr/^{86}Sr$ values found in plants and animals can be directly correlated to those found in the geological material upon which the organisms live (and feed). The natural variation in $^{87}Sr/^{86}Sr$, which is primarily resultant from spatial and temporal differences in geological formation, forms the basis of the hypothesis for this study. One of the few forensic studies into strontium isotope ratios reveals that natural-product drugs (marijuana, in this example) can be used for origin determination.[4] In the case of semi-synthetic drugs, such as heroin in this study, it is believed that batches of heroin that are cultivated and processed in a particular location will share similar radiogenic Sr ratio values. It is assumed that strontium contamination is possible during the processing of opium (morphine) into heroin as well as subsequent packaging and handling; therefore, it is expected that there may be some bias to the heroin $^{87}Sr/^{86}Sr$ values.

Despite this anticipated uncertainty, it has been estimated that ≥70% of unknown samples can be correctly assigned based upon the described methods.[5] As expected, inorganic methods of analysis do not currently possess the discriminating certainty of published methods for organic analysis; however, this research was conducted in order to provide an orthogonal means of analysis to support existing, successful heroin-profiling techniques.[6-8] This has been the first known study to profile heroin by a fusion of inorganic element composition and heavy-element isotopic ratio data.

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