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# Analysis of forensic glass samples and isotope ratio determination

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During the last decade, there has been an increasing interest for istope ratio analysis in the forensic sciences. Most of the activities are related to determination of stable isotopes ratios (N, O, C). Light element isotope ratios have been applied to determination of human (geographical) origin, origin of illicit drugs, origin of gemstones, food authentication and wildlife forensics. Forensic applications of heavy element isotopic ratios include determination of the origin of artefacts, environmental crime and human origin. However, isotopes of heavy elements have so far been less utilized than their light element counterparts, probably because of somewhat more complicated instrumentation, but today the access to appropriate instrumentation is increasing.

The aim of provenance analysis in the geosciences is to determine the geographical or geological origin of a rock/mineral or raw materials formed as a result of a geological process. This is also applicable in a forensic context, when the aim is to determine the geographical/geological origin of an object. It must be emphasised that tracing human origin, the origin of gemstones and of exotic hardwood is rather subtle disciplines within at the forensic laboratory. Most commonly, evidence material of unknown origin (the questioned sample) is compared to equivalent items of known origin (the reference material). The aim of this kind of technical investigation is to either connect the questioned material to the reference material or to eliminate them from being associated. It is expected that the questioned material is related to the criminal act (e.g. that glass fragments collected from some garments originate from a definite, broken window). Methods that aim to identify the geological origin of the raw materials used to manufacture the objects will in this forensic framework be irrelevant, as modern products are a mix of raw material of different origins. The “provenance” for such mass produced products may be the factory, the lot or the production line.

During the technical investigation of a criminal act, glass is often seized as evidence. Glass is easily broken and we frequently see that fragments will attach to different types of equipment (tools) and garments. Today, measurement of refractive index is commonly in use when comparing glass samples. As modern glass production is standardized, refractive index measurements do not give the wanted discrimination of samples from different sources. Other methods like trace element analysis has been carried out in order increase the ability to discriminate samples. This demonstrates that there is a need for new methods to raise the value of glass evidence.

One promising method is the analysis of the isotopic composition of lead in glass by laser-ablation inductively coupled plasma source multicollector mass spectrometry (LA-ICP-MC-MS system). Results of a systematic study of the Pb isotope composition in glass from the reference collection of the Norwegian central police laboratory will be presented.

A core questions in this work is whether the analysis of $^{208,207,206}Pb$ will give sufficient information to draw valid conclusion for the courtroom. Contrary to geochronology, the less abundant $^{204}Pb$ isotope is of minor importance in forensic applications of lead isotopes. As lead concentration in modern glassware is low, leaving out the measurement of $^{204}Pb$ will inherently increase the precession of the obtained data. In this presentation we will discuss topics like discrimination of samples based on isotope ratios, strategies for optimizing instrumental parameters, statistical treatment of data, modelling of datasets and validation strategies. In order to meet the expected claims in the courtroom, the subjects mentioned above should be of general interest for all those working with forensic problems.