B56 Forensic Discrimination of Concrete Pieces From Different Sources Using Inductively Coupled Plasma/Mass Spectrometry (ICP/MS)

Masaaki Kasamatsu, National Research Institute of Police Science, Kashiwa, Chiba 277-0882, JAPAN; Yasuhiro Suzuki, National Research Institute of Police Science, Kashiwa, Chiba 277-0882, JAPAN*

Learning Overview: After attending this presentation, attendees will understand what type of elements are in the acid-soluble components of concrete and the variation in their concentrations when they are from different sources. Attendees will also be shown how to calculate indicators of discrimination based on the concentration of those elements and how to use those indicators to identify differences in concrete.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by presenting a new method of discriminating concrete based on elemental profiles of concrete pieces as physical evidence.

Because concrete is a familiar material used for building structures and block walls, concrete fragments produced in relation to crimes can be important physical evidence. Criminal investigators sometimes have to evaluate the similarity of fragmented concrete samples in order to determine whether they derive from the same origin. Generally, such samples are examined to identify whether they match certain physical structures. In that process, subjective observation should be minimized, because the results may vary from one inspector to another. For those reasons, the forensic discrimination of concrete should refer to objective indicators measured during instrumental analyses, to which end a method focusing on contained trace elements can be effective.

In this study, the components of cement and concrete that are soluble in nitric acid were subjected to ICP/MS. Indices expressed as the ratios of concentrations for selected elements were calculated from the results, and discrimination was performed based on the difference between the intra-sample and inter-sample variations of those indices.

The qualitative analysis of an acid-soluble fraction prepared from a cement sample confirmed that the fraction contained copper (Cu), zinc (Zn), rubidium (Rb), strontium (Sr), zirconium (Zr), barium (Ba), lanthanum (La), cerium (Ce), neodymium (Nd), and lead (Pb). Because the same elements also appeared in another cement sample in the experiment, those elements were used as indicators and quantified. La was selected as the normalizing element due to its relatively high signal intensity and small deviation within the sample. Once differences in the normalized values were detected between the samples, discrimination was performed using those values as indicators.

To discriminate samples, a range of the average value ±2 *SD* was first calculated for each sample, and ranges between two samples were compared. If the ranges did not overlap, then a sufficient difference between them was identified that, in turn, suggested the possibility of discriminating the samples. If the ranges overlapped, however, then no sufficient difference between the samples was recognized, which suggested that distinguishing them would prove difficult. The discrimination of two samples of interest was performed for all combinations.

When only one indicator was used, many pairs of samples could not be distinguished, and although the discrimination power between the samples was insufficient, it could be improved by combining all nine indicators. If multiple indicators did not overlap the range of ±2 *SD*, then the samples were considered to be distinguishable. Of 28 pairs from eight concrete pieces, 26 pairs (about 93%) could be differentiated. By combining indices in that way, the discrimination power improved significantly. Nevertheless, it remained difficult to identify differences in concrete blocks purchased from the same retailer, because commercially available concrete blocks are liable to be produced at the same time. Indeed, when analyzing three concrete blocks from the same batch, the samples were not distinguishable from each other. That result indicates not only that the method can be used to distinguish samples, but also that samples from the same origin could be the same.

Because cement can be nearly homogeneous when making concrete, focusing on cement as an acid-soluble component is appropriate for forensically discriminating concrete. Furthermore, because the method used involved comparing ratios, it stands as an excellent approach that does not require determining the dilution ratio of the sample during pretreatment for acid decomposition.

Concrete, Forensic Discrimination, ICP/MS