B9 Distributions of Elemental Concentrations Within Individual Sheets of Float Glass

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The goal of this presentation is to provide attendees with a context within which to make statistical inferences concerning the compositional similarity of fragments recovered from a broken sheet of glass.

This presentation will impact the forensic community and/or humanity by presenting data and concepts that are fundamental to the proper selection of match criteria when performing elemental compositional comparison of glass fragments.

Statistical criteria used for the comparison of element concentrations in glass fragments are typically based upon assumptions concerning sample homogeneity, the distributions of element concentrations, and independence of variables. In order to test these assumptions, a study has been performed in which the concentrations of a number of major, minor, and trace elements were determined in representative samples from three sheets of float glass. Representative samples from three panes of glass, a 4'x4' pane of ¼" nontempered float glass and two tempered automobile side windows, were selected for analysis after dividing the sheets into squares using a grid pattern. The concentrations of up to 40 elements were determined using solution- based ICP-AES and direct solid sampling by LA-ICP-MS and LIBS. The number of replicate samples analyzed from each selected grid square was selected according to the characteristics of the sampling method. For example, larger fragments are required for a dissolution method than for laser sampling, so fewer replicates are needed to obtain a representative sample. The resulting data were evaluated graphically and by statistical tests, including ANOVA and Tukey's HSD, to determine where significant elemental differences exist within a given sheet.

The results of this study provide data that can be used to provide insight into several aspects of the evaluation of compositional data in glass. First, the results indicate the relative capabilities of the three analytical methods used, including the effects of sample size on the analytical precision and the perceived lack of homogeneity in some glass sheets. The nested ANOVA data evaluation helps to ascribe observed variations in element concentration to analytical imprecision and source heterogeneity. Second, the distributions of the analytical data, including precision measures on each data point, provide insight into whether the results meet certain statistical requirements, such as data normality required for a t-test. Finally, the multiple measures for each source allow the use of leave-one-out methods to evaluate the effectiveness of several match criteria, by directly measuring the frequency of false exclusion errors with each criterion. The data also prove particularly useful for evaluating methods of minimizing the combined error effects prevalent in multivariate comparison schemes.

Glass, Elemental Analysis, Statistics

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