APPLICATIONS OF CREATIVE TECHNIQUES IN X-RAY FLOURESENCE ANALYSIS: A STUDY OF ENVIRONMENTAL LEAD EXPOSURE FOR CHILDREN NEAR KAMPALA, UGANDA

By

Karen V. Merrill

An Abstract of a Thesis Submitted to the Graduate Faculty
of Rensselaer Polytechnic Institute
in Partial Fulfillment of the
Requirements of the Degree of
MASTER OF SCIENCE
Major Subject: GEOLOGY

The original of the complete thesis is on file
in the Rensselaer Polytechnic Institute Library

Approved:

Richard F. Bopp
Thesis Advisor

Rensselaer Polytechnic Institute
Troy, New York
May 2010
(For Graduation May 2010)

ABSTRACT

Modern x-ray fluorescence (XRF) is rapidly becoming the favored method for elemental analysis of sediment and other media due to its speed, accuracy and the limited sample preparation required compared to other techniques. Elemental analysis using an XRF device allows for accuracy and precision similar atomic absorption spectrometry (AAS) and inductively-coupled plasma mass spectrometry (ICP-MS) for a wide range of elements without the labor-intensive, time-consuming acid digestion process those methods require. By utilizing the XRF method the scope of projects can be dramatically increased allowing for more conclusive research and results. A minor obstacle encountered with this technique is that sample mass can be limiting because a minimum mass of approximately 1.5 grams is necessary for results with less than 10 percent error for most elements. This can be problematic when analysis of low-mass samples such as house dust is desired. A creative solution involving dilution of a known amount of sediment sample with a known amount of well-analyzed diluting agent such as silicic acid or alumina powder can be applied. It has been demonstrated during this study that the results can be used to solve for the unknown sediment concentrations.

The XRF method was used to complete a large-scale, multidisciplinary study of environmental lead exposure of 163 children in Kampala, Uganda by analyzing the children's blood lead levels, and soil and house dust samples from their respective homes. A project of this scale was made possible by the speed and ease of analysis the XRF provides and the analysis of low-mass dust samples was made possible by the application of the dilution technique developed during this study. The soil and house dust elemental data was used in conjunction with blood lead, geographic and socioeconomic data to conclude that despite the phase-out of leaded gasoline, environmental lead exposure associated with the nearby Kiteezi Landfill, remnant lead in soils near roadways derived from vehicle exhaust, and other sources remains an issue.

The practical advantages of the XRF method are certain to make it a dominant technique in future analytical studies. As a result of the successful application of the XRF dilution

method to analyze low-mass dust samples, it is likely that the method could be applied to other sample types that are typically available only in small quantities such as suspended river sediment.