

## Using XRF to Identify Multiple Environmental Hazards in St. Joseph County, IN

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Utilizing a citizen science sample collection kit designed to identify lead exposure hazards, approximately 5000 soil, dust, paint, and pet hair samples have been collected throughout St Joseph County, IN and analyzed with X-Ray Fluorescence (XRF) spectroscopy. A strong correlation was discovered between lead and bismuth concentrations in a subset of soil samples and nearly all the paint samples, with lead levels approximately 150 times higher than bismuth. However, some soil samples contained lead with no bismuth present. Since most lead sources likely contain bismuth as an impurity from refining of native lead ore, but leaded gasoline should not contain any bismuth impurities due to the manufacturing process of tetraethyl lead, it may be possible to distinguish environmental lead sources by XRF. To test if XRF could distinguish if soil lead contamination comes from leaded paint or leaded gasoline, two major sources of environmental lead contamination, leaded paint samples were analyzed with Inductively Coupled Plasma – Optical Emission Spectroscopy (ICP-OES), which confirmed the presence of bismuth in leaded paint, and aviation gasoline, which still contains tetraethyl lead, was also analyzed by ICP-OES and confirmed the absence of bismuth in leaded gasoline. This discovery suggests that XRF can be used to rapidly distinguish different legacy lead contamination sources from one another.

In addition to the findings on environmental lead contamination, XRF and Particle Induced X-Ray Emission (PIXE) spectroscopy revealed that nearly all pet hair samples contained unusually high levels of bromine, most likely from brominated flame retardants (BFRs), common additions to household furniture, carpets, and electrical appliances. To investigate further, X-Ray Photoelectron Spectroscopy (XPS) was used to observe bromine levels on the surface of the hair and hair washing procedures were used in order to distinguish between surface contamination of BFRs and the incorporation of BFRs into the hair itself. Gas Chromatography/Mass Spectroscopy (GC/MS) was used to identify the specific BFRs present. These findings have demonstrated that the high-throughput capacity and the ability to reveal elemental trends via quickly uncovering most of the atomic makeup of sampled media makes X-Ray spectroscopy techniques invaluable in identifying environmental pollutants.