Portable GPS-XRF for Real-Time, On-Site Metal Mapping

K. Russell, Innov-X Systems, Inc.

Abstract: The advent of real-time integration of portable XRF results with GPS coordinates provides instant visualization of data trends and provides a powerful, real-time decision making tool. An overview, including technical considerations, will be given of three typical methods used to carry out metal mapping with GPS and portable XRF – manual integration of the two data sets; automated integration of the two data sets; and completely automatic integration of the two data sets into customized, formatted templates with 3D visualization displayed and modeled utilizing ESRI's ArcPAD© Mobile GIS. Additionally, representative environmental, archaeometry, and geochemistry applications will be presented.

Manual XRF-GPS Data Integration

- Automatically record metal analysis on Portable XRF
- Automatically record mapping coordinates on GPS Unit
- Manually integrate both data sets for metal mapping

***St Anselm College:** Study of Ancient Roman Drainage System Lead Pipe & Connective Keys; Orvieto, Italy*

XRF Integrated with US EPA's R.A.T.

- Integrates real-time GPS positions with XRF data for instantaneous snapshots of field condition
- Collected data can be exported using standard USEPA formats such as SCRIBE and ESRI Shapefile
- Built-in sample design methodology to allow instantaneous sample plan development
- 3D visualization can be displayed and modeled

Commercially Integrated Portable GPS-XRF

- OMEGA Portable XRF with Soil Calibration
- TRIMBLE Nomad Field Computer with GPS
- Mobile GIS on Trimble (ArcPAD or Discover Mobile)
- Mobile GIS Extension Software on OMEGA (Bluetooth comm SW b/w Omega/Trimble/ GIS)
- (ioGAS) ioGLOBAL's Geochemical Analysis SW
- Soil Extension Pole and Soil Foot

Mapping Heavy Metal Distributions In and Around Riverside Park, Milwaukee, WI

An Innov-X field-portable x-ray fluorescence spectrometer (pXRF), coupled with a sub-meter accuracy GPS, is being used to create a geochemical map of heavy metal distributions throughout the park and surrounding neighborhoods. Geochemical mapping is an important part of understanding the spatial distribution and extent of contamination and can aid in planning remediation efforts and future land usage. Sampling locations include the riparian zone along the Milwaukee River, urban forest land, athletic fields, a rails-to-trails corridor, a playground, roadsides and residential areas. In addition to field mapping of metal distributions, soil parameters including pH, Point of Zero Salt Effect and Loss on Ignition analyses were performed to further characterize the soils.

URBAN PARK SAMPLE LOCATION & PROTOCOL:

In order to gain a greater knowledge and understanding of the extent of soil contamination in the area of the former impoundment many samples were taken from areas covering a variety of land uses and distances from the former impoundment. Sites included Riverside Park (an urban forested park on the east bank of the Milwaukee River), a playground within Riverside Park, a rails-to-trails corridor, athletic fields, Gordon Park (similar to Riverside Park but located on the west bank of the Milwaukee River), school grounds and nearby residential properties.

	n	Average Pb Concentration	Standard Deviation	Low	High	% > 400 ppm
Drip Zone	21	1540	1686	23	7090	71
Front Yard	16	376	345	28	1123	44
Back Yard	16	343	251	16	975	44
Roadside	25	146	103	14	421	4
Garden	16	310	309	21	1336	31
Corner	3	84	57	18	121	0

Residential Sample Data Statistics: The 'Drip Zone' samples have the highest concentration of Pb, 71% of these samples have concentrations that are over the EPA limit of 400ppm. Though the back yard, front yard and garden samples have much lower concentrations of Pb there is still a large portion of them that are over the DNR threshold. Chemical analyses were done using an Innov-X pXRF

The map above is a Kriging overlay of Pb concentrations in the Riverside Park area. Running parallel to the shoreline, including point A, is the area that was inundated by the dam impoundment. The residual soils from this area show a clear elevation in metal concentrations as seen on the map, where the maximum Pb concentrations are in soils that were impacted by the impoundment but are generally outside of the area currently influenced by the river.

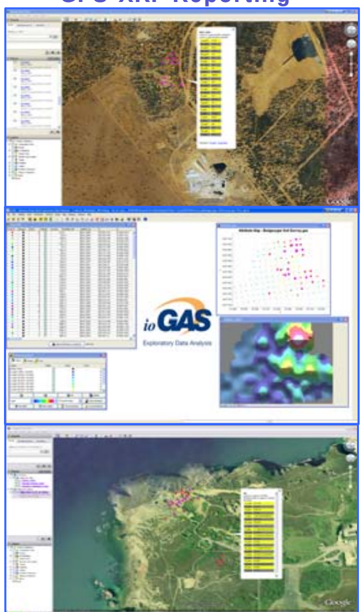
The northern and eastern bounds of this map, including point B, also display elevated Pb concentrations where the mapped area is bounded by busy roadways. The roadside increase in Pb is most likely remnant from the days of leaded gasoline.

The central zone of the map, C, shows another spike in Pb levels. This area was largely unmapped as it was private industrial property. Samples were taken along the edge of the property and ArcMap extrapolated the data into the unsampled area. The industry in the site may have lead to the deposition of Pb in the area.

The areas of elevated Pb concentrations on this map represent three of the possible vectors of soil contamination in an urban environment.

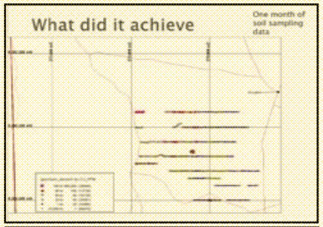
Work performed by an Innov-X Academic Grant Award Recipient

GPS-XRF Reporting



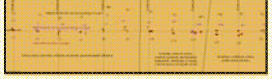
CASE STUDY: phoenix COPPER

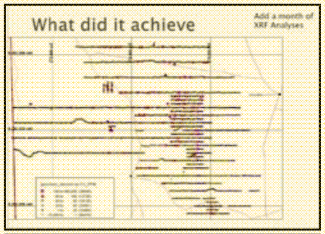
Soil sampling with only Lab ICP Analysis consumes time/expenses. Portable XRF-GPS with Lab ICP spot checking provides low-cost, real-time decision making data.

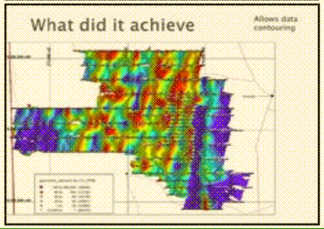


Accurate

- The Innov-X Omega 6000 has proven remarkably accurate against laboratory assaying on both the 30 second and 60 second readings.
- Assays generally contoured in the same broad categories for Cu 0-20ppm, 20-40ppm, 40-80ppm, 80-160ppm and >160ppm.
- From the orientation line data PNX decided to use the XRF on 30sec readings on Cu projects like Spalding below.







- From the orientation line data PNX decided to use the XRF on 30sec readings on Cu projects.
- Therefore depending upon line spacing and topography about 240 analyses can be taken in an average 8 hour day.
- Phoenix has collected over 25,000 analyses in the past 12 months
- Laboratory assays with a similar but less extensive suite of elements cost us ~$37.50 each and we have taken 2000 of those as check and follow up assays.
- Had the XRF sampling been done conventionally it would have taken an extra year or two and cost an extra $937,500
- The ~$75,000 investment was well worth while.