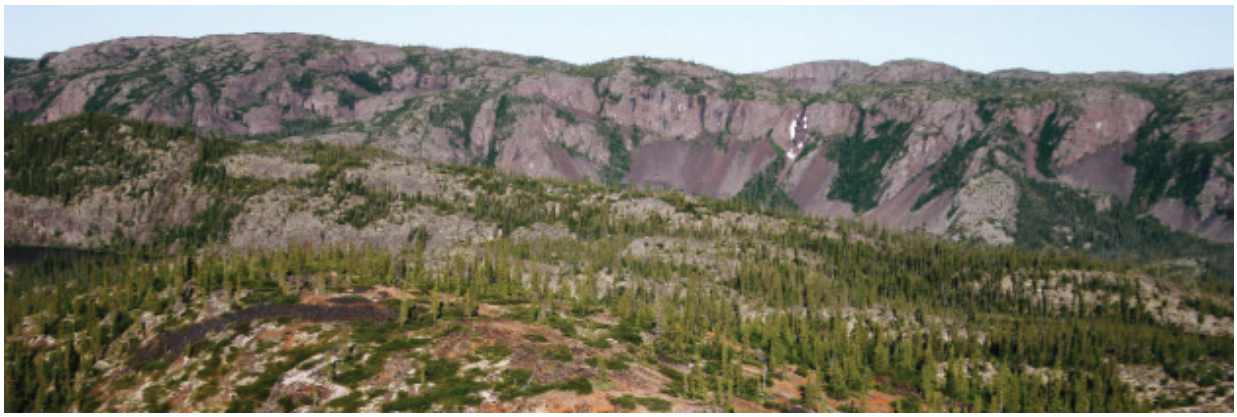
Use of Sample Preparation Tools in Mining and Mineral Exploration Projects

Example from a Base Metal Ore Deposit



Introduction

Lab-based techniques such as inductively coupled plasma and atomic absorption spectroscopy (ICP and AAS) are used commonly for analyzing geological samples. These techniques utilize homogeneous rock powder, which eliminates the effects of heterogeneity and uneven distribution of ore minerals in the groundmass or veins/veinlets. However, these methods require completely dissolving the samples in a solution. Since complete dissolution is not achievable for many minerals (including some ore minerals), the assay values are not truly complete. In addition, commonly less than 1 gram (gr), in some cases 0.25 gr, of the rock powder is used. It should be noted that one meter of core sample is ~5000 gr and half of that (~2500 gr) is sent to the lab for analysis. The ~2500 gr sample (half core) is ground and homogenized, and only a 1 gr sample is actually analyzed. The analyzed portion (≤1 gr, or ~0.04% of the half core), theoretically represents the 2500 gr sample.

Application

The use of portable x-ray fluorescence (XRF) in mining and mineral exploration projects has accelerated in the last decade and the Thermo Scientific portable XRF analyzer is a pioneer in this industry. In the conventional application of portable XRF, samples are simply "shot" (scanned) with the instrument. Although this method provides very effective and fast results, the heterogeneity of samples in some deposit types can be an issue. In order to improve the efficiency of the Thermo Scientific portable XRF instrument when analyzing heterogenous rock samples, we introduced a sample preparation tool kit.

The goals of this application study are to:

- Compare assay results from prepared samples with those from unprepared samples
- Compare assay results of portable XRF from prepared/unprepared samples with lab assay data
- Identify copper-molybdenum (Cu-Mo) anomalous zones at depth using portable XRF assay data

To achieve these goals, three sets of analyses were conducted on samples from a mineralized drill hole in northwest Canada. These assays include direct shot on the core with the analyzer, as well as analyses of powder samples obtained from the portable mill and grinder.

Portable XRF Analyzer

Our advanced, handheld, Thermo Scientific Niton XL3t Series XRF analyzers, including the high-performance Niton® XL3t GOLDD+ analyzer, deliver accurate elemental analysis with unmatched efficiency for companies across all stages of the exploration,

Sample prep tools and Thermo Scientific Niton XL3t GOLDD+

mining, and refining processes. These instruments make it easy to perform trend analysis by averaging readings in real-time or by downloading results later to a PC.

Niton XL3t Series analyzers provide the following key benefits:

- Immediate geochemical analysis of ore, rock, drill core, chips, and rock face
- Help in confirming mineral deposit models
- Assistance with recognition of new or unexpected types of ore mineralization
- Drastic reduction of the number of samples sent for lab analysis
- Decision-making tools at your fingertips
- Ore concentration tracked instantly
- Low levels of detection for more than 25 elements, including light elements (Mg-S) with GOLDD technology

Further, our unique Thermo Scientific TestAll Geo technology provides a powerful feature that can automatically determine the correct analytical test mode for the rapid analysis of major, minor, and trace elements in geological samples.

Methodology

Field tests with the portable mill and angle grinder/sampler were carried out in a Cu-Mo porphyry complex in northern British Columbia, Canada. In this deposit, the host rock is granite to granodiorite with moderate to strong hydrothermal alteration. Mineralization varies from disseminated to sporadic veins and veinlets of quartz±chalcopyrite±bornite± molybdenite (very heterogeneous rock type). Two sets of duplicate specimens were sampled from a mineralized drill core. Each sample represents one meter of drill core. Three analyses were performed on each sample using the Thermo Scientific Niton XL3t GOLDD+ analyzer (Mining Mode, % and ppm).

1. Analysis of powder (sampled by grinder) after making a cup
2. Analysis of powder (sampled by mill) after making a cup
3. Simple scan/shot of the core along its length (one meter) for 80 seconds

The cups were fitted with polypropylene film and measured for 240 seconds (60 seconds each filter).

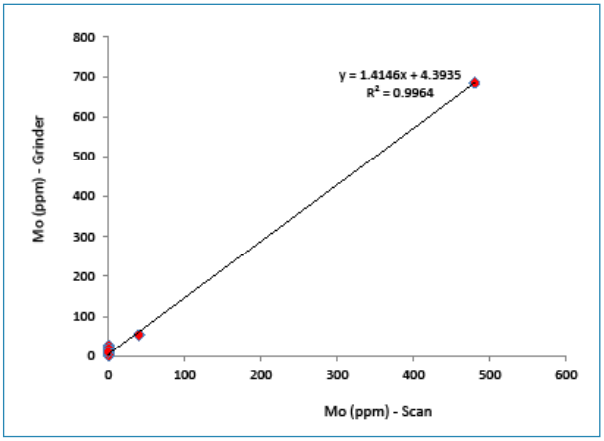


Figure 1. Correlation between Mo values measured by portable XRF (scanning vs. grinder powder).

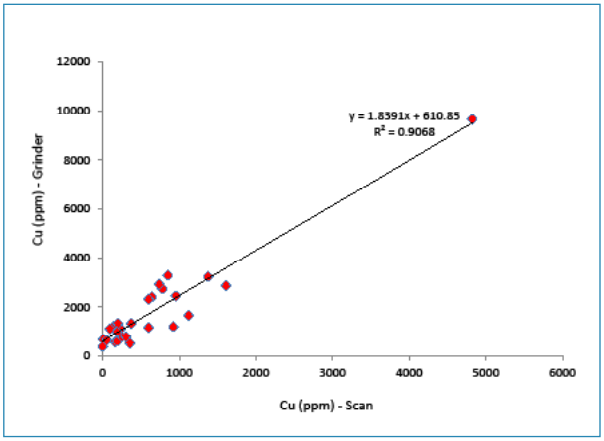


Figure 2. Correlation between Cu values measured by portable XRF (scanning vs. grinder powder).

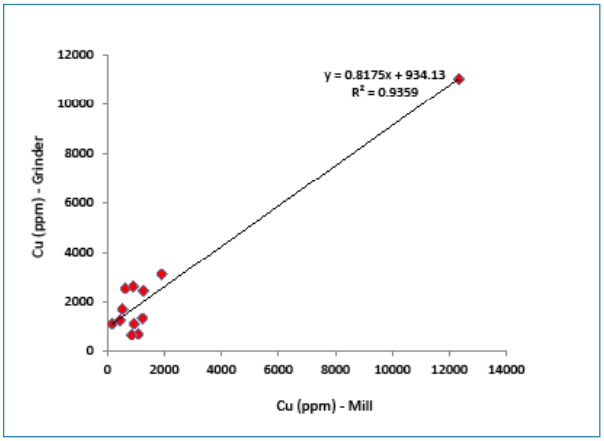


Figure 3. Correlation between Cu values measured by portable XRF (mill powder vs. grinder powder).

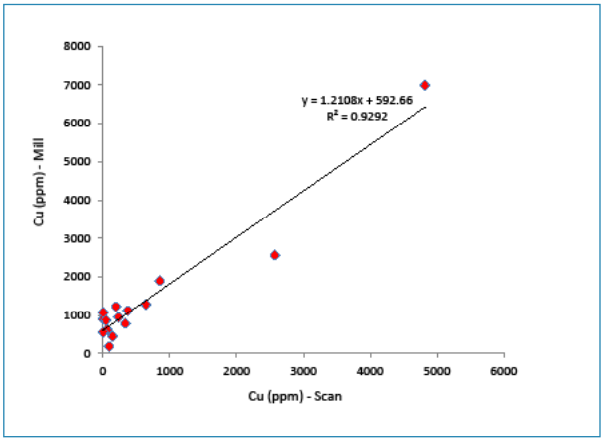


Figure 4. Correlation between Cu values measured by portable XRF (scanning vs. mill powder).

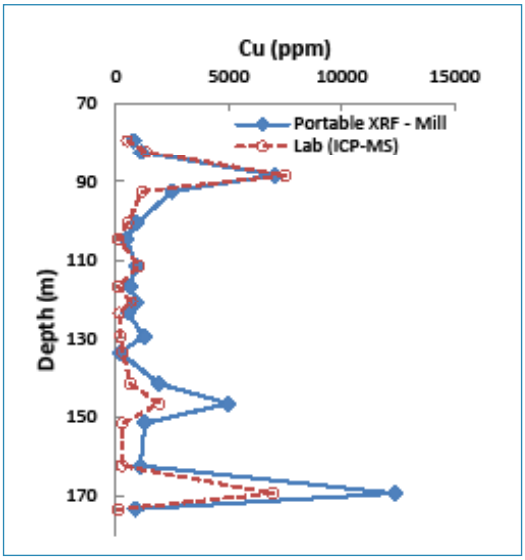


Figure 5. Depth-Cu graph showing Cu anomalies determined by both portable XRF (mill powder) and lab methods.

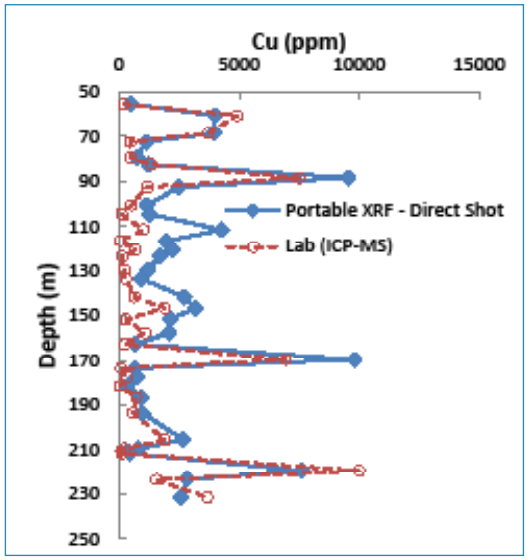


Figure 6. Depth-Cu graph showing Cu anomalies determined by both portable XRF (direct shoot) and lab methods.

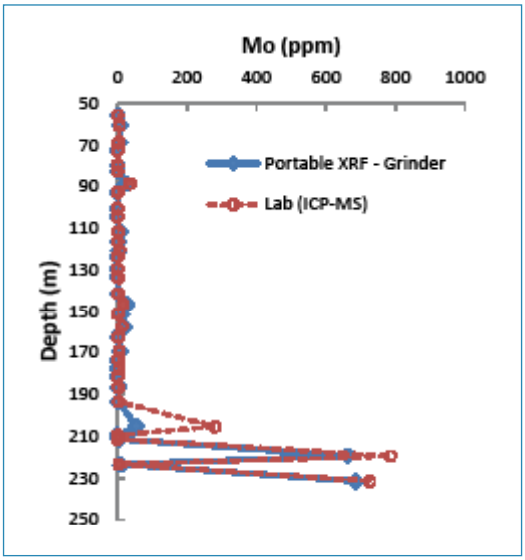


Figure 7. Depth-Mo graph showing Mo anomalies determined by both portable XRF (grinder powder) and lab methods.

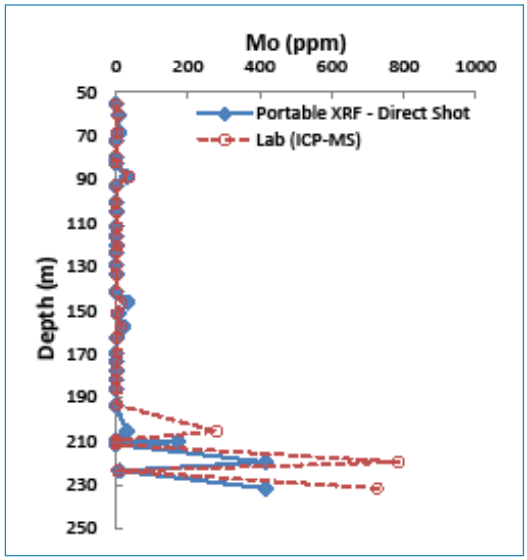


Figure 8. Depth-Mo graph showing Mo anomalies determined by both portable XRF (direct shot) and lab methods.

Results

The coefficient of determination, the R^2 value, is a measure of how closely the data sets correlate with each other, where a perfect correlation would have an R^2 of 1. The previously mentioned three methods provide similar assay results as shown by R^2 values of >0.9 (see Figures 1-4). However, scanning (direct shot) of very heterogeneous samples may not produce repeatable assays (see Conclusions section at the end of this report).

Comparison of assay data from the three methods of portable XRF analyses with lab data shows that Cu correlation (R^2) increases from 0.81 in direct shot assays to 0.84 and 0.86 in powder samples from the mill and grinder, respectively (see Table 1). Mo correlation increases from 0.87 in direct shot analyses to 0.95 in samples obtained by the grinder. Zinc (Zn) correlation also increases by using powder samples from the mill and grinder. This indicates that the effects of heterogeneity are minimized significantly by using powder obtained by these tools.

In addition, depth-metal diagrams show that Cu and Mo anomalous zones can be identified by using both prepared and unprepared samples analyzed by the Niton XL3t GOLDD+ analyzer in the field as shown in Figures 5-8. However, the size and shape of these anomalous zones determined by assay results from prepared samples may be closer to the reality.

Analysis Method	Cu	Mo	Zn
Direct shot vs. Lab	0.81	0.87	0.66
Angle Grinder vs. Lab	0.86	0.95	0.82
Portable Mill vs. Lab	0.84	NA*	0.88
* Mill material contains Mo.			

Table 1. Correlation (R^2) between Thermo Scientific portable XRF analyzer and lab assays (ICP-MS).

Conclusions

Using sample preparation tools improve correlation with lab methods. Either of the following methods can be used in the mining industry, depending on the application and purpose of analyses.

- Scanning method (direct shot) for unprepared samples (such as core specimens):
  - Fast
  - Assay results will be similar to those from prepared samples, but may not be repeatable because in each assay a different section of the sample will be analyzed (effects of heterogeneity).
  - Suggestion: Scan several places on the sample and take the average.
- Analysis of prepared samples (powdered by mill or grinder)
  - Takes a few minutes to prepare each sample.
  - Assay results are repeatable.
  - XRF analysis is nondestructive, allowing a portion of the prepared sample to be sent to the lab for direct comparison of techniques.

Geochemically anomalous zones, Cu and Mo in this study, can be easily identified using a Thermo Scientific portable XRF analyzer in the field. This study shows that even the direct shot method of analyzing unprepared samples can be used to identify these anomalous zones. This finding can be very important for early and mid-stage exploration projects to identify drill targets and improve the efficiency of exploration programs.

Direct rock sampler

To discuss your particular applications and performance requirements, or to schedule an on-site demonstration, please contact your local Thermo Scientific portable XRF analyzer representative or contact us directly by email at niton@thermofisher.com, or visit our website at www.thermoscientific.com/niton.

Crusher tool

Electric hammer mill

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