Using Thermo Scientific Portable XRF instruments for analyzing ore concentrates and grade control

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Application Note

Introduction

Most natural ore deposits do not have high mineral or metal concentrations. As a result, ore grading and mineral concentration are necessary processes in making final product (i.e. metal) from the original raw material. While portable X-ray fluorescence (XRF) can be easily used to determine elemental constituents for most natural low concentration samples, its application in concentrated ore samples can be more challenging.

Field Portable XRF Analyzers in Mining

Field portable XRF (FPXRF) is a technique with the ability to deliver fast and accurate elemental analysis results with little or no sample preparation in various stages of mining activity from grass root exploration to exploitation, ore grade control, and even environmental investigations.

There are more than 3,000 Thermo Scientific™ portable XRF analyzers that are used extensively throughout the global mining industry. A broad range of elements from magnesium (Mg) to uranium (U) can be analyzed using these instruments.

The following Thermo Scientific™ handheld products – Niton™ XL3t and Niton XL2 series analyzers and the Niton FXL field x-ray lab – bring transformative improvements related to data acquisition time, offer excellent limits of detection (LOD) and provide accurate results over a wide range of samples.

Application

After being identified and extracted, ore minerals are often concentrated by a variety of techniques (from mechanical separation such as screening to chemical separation including floatation and acid leaching) utilizing their physical and chemical properties. The product of such processing is a uniform and homogeneous mineral concentrate with relatively simple composition/mineralogy. The UserMethod, also known as Empirical Mode, is the most useful portable XRF method for analyzing concentrate samples considering their homogeneous composition.

It is notable that the Fundamental Parameter (FP) factory modes are general purpose modes that work well for a wide variety of sample types. The FP mode is also "standardless" and does not require known samples to obtain quantitative results. In the high concentration processed samples, the concentration of metal of interest is usually reported less than the true value if regular FP method is used. For such samples, in order to obtain accurate quantitative results, it is recommended to use the UserMethod. In this method, samples are analyzed and the quantities are reported as intensity (counts per second per microamp rather than as percent or ppm). Then calibration curves are plotted based on known concentrations (from laboratory values) and intensity (from portable XRF). The equation of trend line in these graphs is used to convert portable XRF readings (in unknown samples) from intensity to percent (see Figure 1).

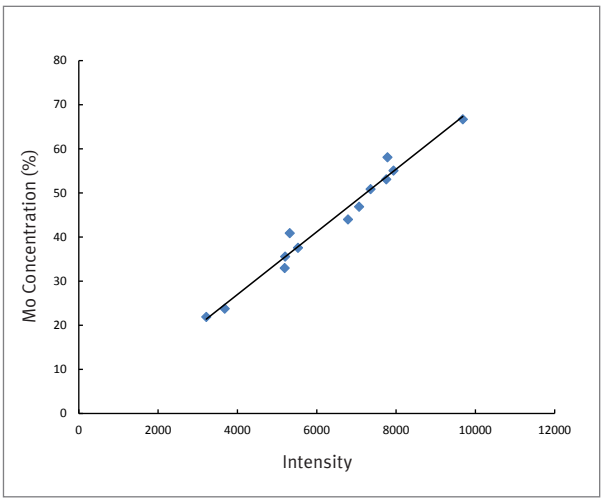

Figure 1. Example of generation of calibration curve

Method

This case study was carried out using UserMethod by a Thermo Scientific™ Niton™ XL3t GOLDD™ analyzer on molybdenite (MoS_2) concentrate samples. Ore grade in such concentrates may vary from 25% to 65% Mo. Concentrations of molybdenum (Mo), iron (Fe) and copper (Cu) in these concentrates along with correlation with lab assay data are shown in Figure 2.

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Results

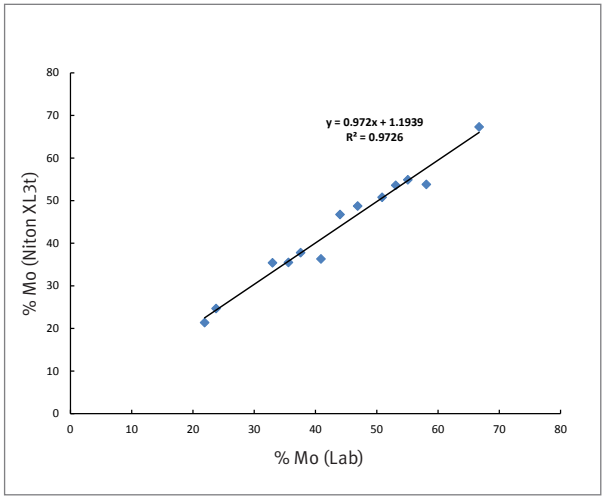
The coefficient of determination, the R^2 value, is a measure of how closely the data sets correlate with each other, where a perfect correlation would have an R^2 of 1. The correlation for Mo, Cu and Fe are 97%, 99% and 97%, respectively (see Figure 2). The m value beside x in the trendline equation indicates the accuracy of the results, with all three elements showing excellent agreement.

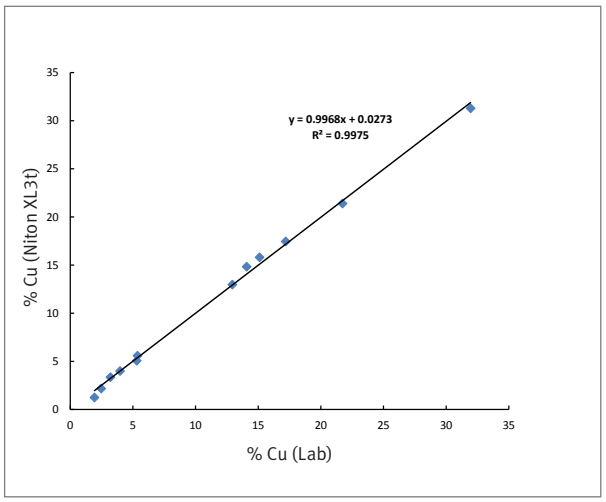
Conclusions

Field portable XRF is a very reliable and effective tool to analyze any type of sample not only in the exploration stage (low grade) but also in the ore grading stage (high grade). For concentrated mineral samples, the UserMethod can often provide reliable and accurate data, and will read results directly on the instrument screen once a UserMethod is uploaded, thus providing the instant results required on the production line for maintaining the correct grade control.

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

Special thanks to Freeport–McMoRan Copper & Gold, Inc. for collaboration and providing the analyzed samples.





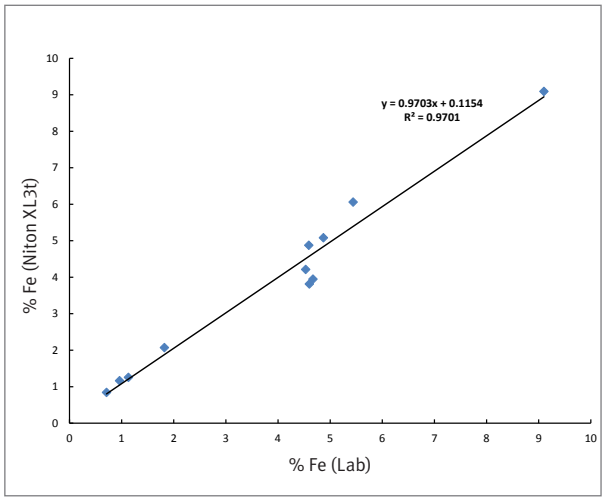


Figure 2. Correlation of Mo, Cu and Fe data between portable XRF and lab in molybdenite (MoS_2) concentrate samples.

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