Application of the Thermo Scientific FXL Field X-ray Lab in Geochemical Exploration and Delineation of Ore Zone

Example from the Francisco I. Madero Zn-Pb-Cu-(Ag) Deposit, Zacatecas, Mexico

Introduction

Portable x-ray fluorescence (XRF) applications in the mining industry have increased tremendously in the 21st century. There is no doubt that these valuable instruments can play a significant role not only in grass root exploration projects, but also in advanced mining programs and even daily routine grade control and ore processing. With increasing global demand for metals, minerals, and petroleum, there is a growing need for exploration and mining activity. Exploration of new prospects is challenging, since the most accessible and obvious ore deposits have already been explored and mined. This circumstance reinforces the importance of identifying geochemical exploration keys and models that can be used to facilitate new discoveries.

Application

Exploration keys are defined based on our understanding of physical and geochemical processes that contribute to the origin of mineral deposits. Understanding these processes will facilitate the development of more refined genetic models, which will lead to better exploration strategies and improve the odds of success for global mineral exploration. This area of economic geology/geochemistry requires low detection limits and high accuracy, comparable to those from the lab-based assays, but much faster real-time analyses in the field. The Thermo Scientific Niton FXL field x-ray lab, using XRF technology, meets these needs.

The goals in this application study are to:

- Compare Niton® FXL analyzer results with lab assay
- Identify geochemically anomalous zones of:

  Ore metals – These can be used directly to locate drill targets

  Light elements (such as Al, S, Si) – These can be used to identify hydrothermal alteration zones and exploration keys that can vector to locate and characterize centers of hydrothermal activity and mineralization.

Portable XRF Analyzer

The Niton FXL Series field x-ray lab delivers XRF-based elemental analysis with lab-quality testing performance and low levels of detection for up to 40 critical elements. Housed in a compact, portable package that can be operated virtually anywhere on-site – from the back of a truck, mounted on a tripod, or in an on-site lab. It has a rechargeable battery and is designed to operate in dusty, harsh field environments. This elemental analysis lab offers outstanding performance, features, and mobility.

- True lab-quality performance with superior limits of detection
- Nondestructive with accurate, consistent elemental analysis in minutes – or less

Operate the Niton FXL virtually anywhere on-site.

- Easy to use, with little operator training required
- Lightweight and ruggedly designed for field and manufacturing operations
- Available with 1 mm, 3 mm, and 8 mm spot sizes
- Sample spinner for reducing sample heterogeneity issues due to grain size
- Closed-beam design requires minimal licensing in most countries

Methodology

This investigation was carried out in the Francisco I. Madero zinc-copper-lead-(silver) (Zn-Cu-Pb-(Ag)) deposit, which is owned by Peñoles and operated as an underground mine in Zacatecas, central Mexico. There are two types of sulfide ore assemblages in the ore body: 1) Pb-Zn sulfides as NW trending 6-65 m thick masses composed of bands and laminations of sphalerite and galena cut by quartz, clay-pyrite, and chlorite-epidote veins at the base of the ore body in an area of 6 km^2, and 2) Cu-Ag sulfide assemblage consists of chalcopyrite, pyrite, cubanite, enargite, and tetrahedrite as laminations and bands in 3-40 m thick ore masses cut by quartz-pyrite-chalcopyrite veinlets.

To achieve the goals of this investigation, powdered drill core samples were analyzed by ALS using inductively coupled plasma emission spectroscopy (ICP-ES) and the Niton FXL field x-ray lab. The filter time was set up for 120 seconds (30 seconds each filter) using the Thermo Scientific TestAll Geo feature of the software and Mylar® film on the sample cups.

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 study shows high correlation between data from Niton FXL analyzer and lab methods (see Figures 1-4, Table 1). If required, user calibration factors can be inserted to correct for any bias between lab and XRF data.

Analysis Method	Pb	Cu	Zn	Fe
Niton FXL vs. Lab	0.98	0.92	0.97	0.90

Table 1. Correlation (R^2) between Thermo Scientific Niton XRF analyzers (Niton FXL) and lab assays (ICP-ES).

In addition, systematic analyses of core samples and comparative study (see Figure 5, back page) indicate that geochemical anomalies of not only metals but also light elements (such as sulfur) can be identified readily in real time using the Niton FXL analyzer in the field.

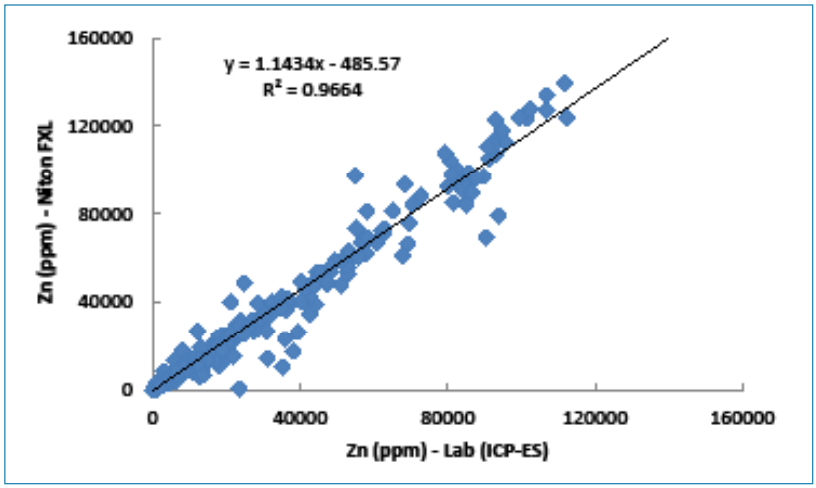


Figure 1. Correlation between Zn values measured by Niton FXL analyzer and ICP-ES.

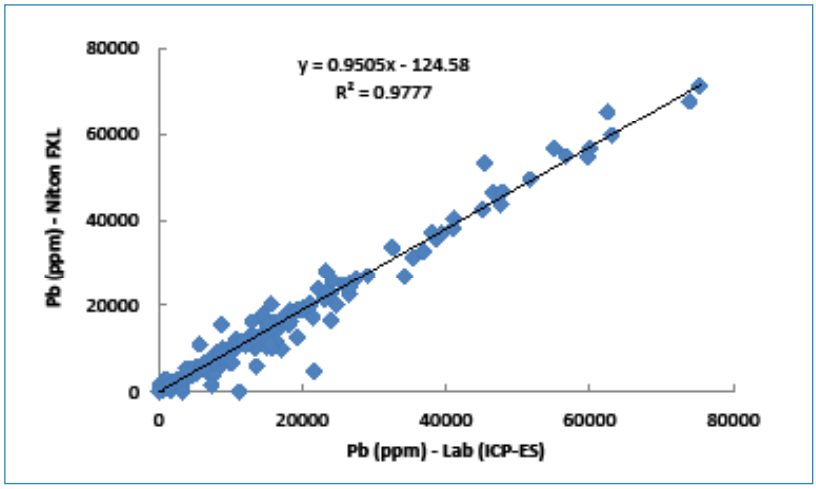


Figure 2. Correlation between Pb values measured by Niton FXL analyzer and ICP-ES.

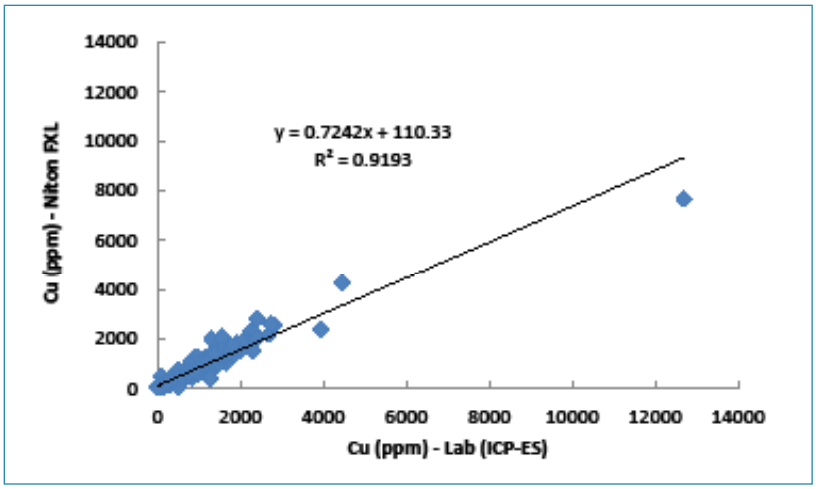


Figure 3. Correlation between Cu values measured by Niton FXL analyzer and ICP-ES.

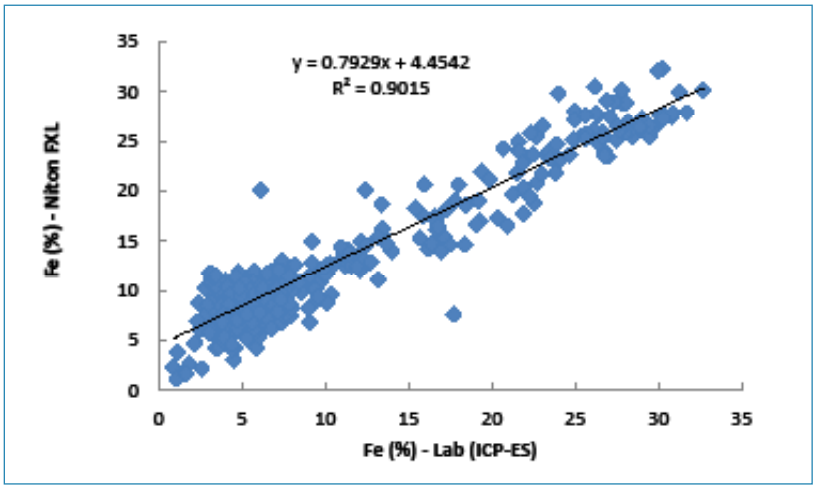


Figure 4. Correlation between Fe values measured by Niton FXL analyzer and ICP-ES.

Conclusions

High correlation between Niton FXL data and lab assays on the large number of samples in this study, along with identification of geochemically anomalous zones at depth using data from the Niton FXL field x-ray lab, indicate the efficiency of this instrument in locating centers of hydrothermal activity and mineralization, which are the prime targets for exploration and mining. Such real-time access to assay data in the field helps geologists to make decisions on time and efficiently manage their mining projects saving time and money.

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.

We would like to thank Peñoles, Zacatecas, Mexico, for its assistance and cooperation with this project.

Easily and accurately analyze powder or pelletized samples.

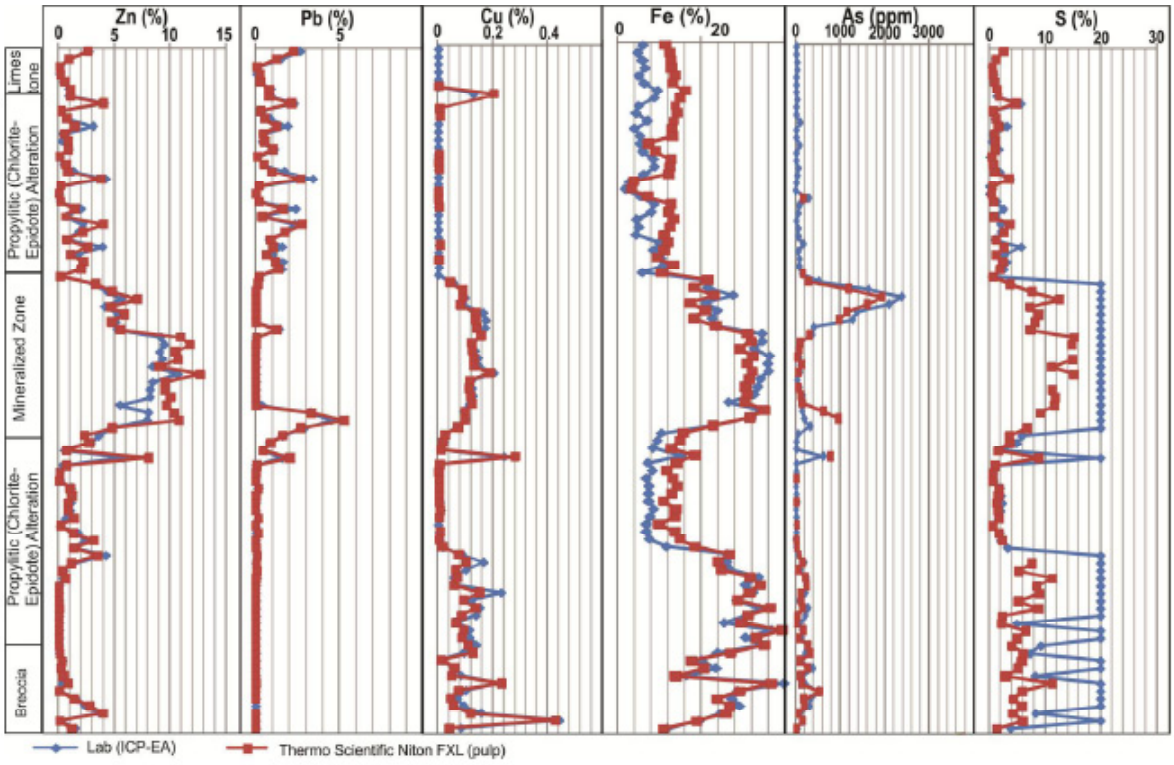
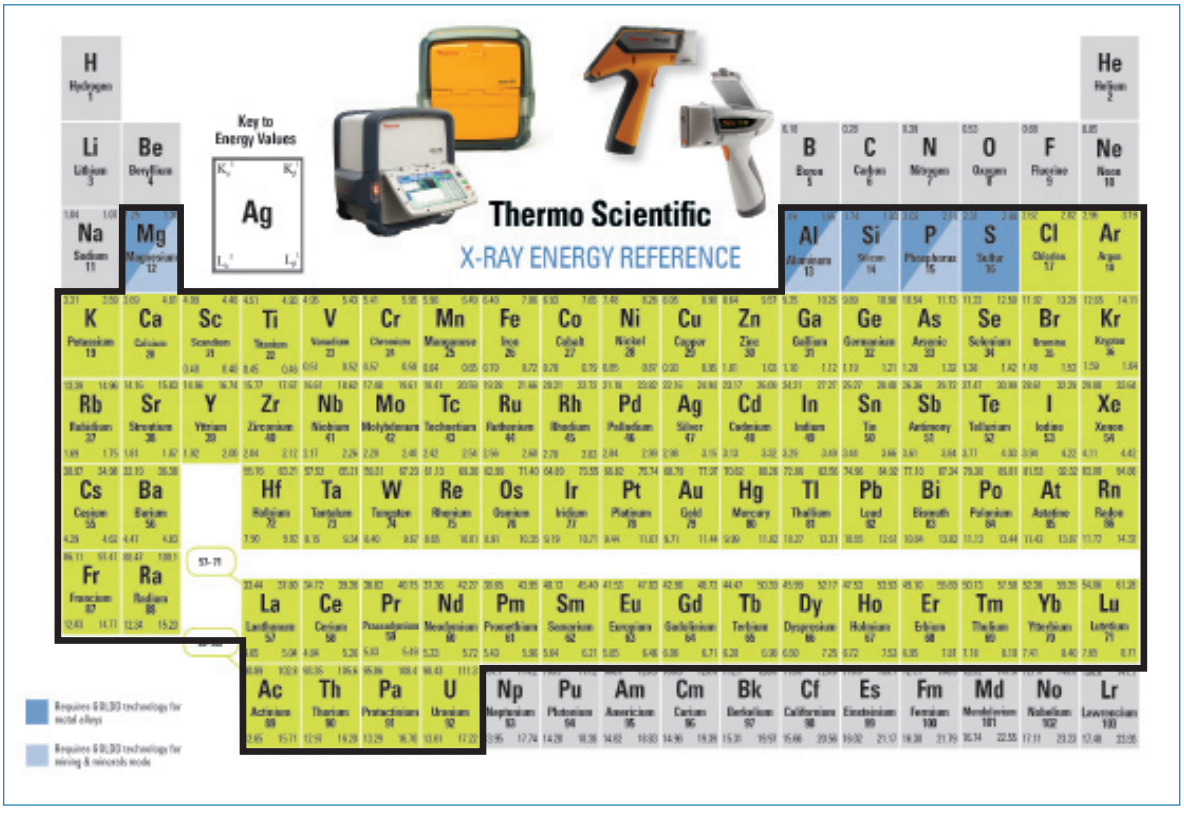


Figure 5. Depth vs Zn, Pb, Cu, Fe, As, and S graphs showing the efficiency of the Thermo Scientific Niton FXL field x-ray lab in identifying mineralized and geochemically anomalous zones.



Thermo Scientific Niton FXL Series analyzers deliver lab-quality testing performance and low levels of detection for up to 40 critical elements.

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5-320 01/2012