Iron Ore Mining and Grade Control Using Thermo Scientific Portable XRF Analyzers

Introduction

Iron (Fe) is the most common element, by mass, forming the planet Earth, and is the fourth most common element found in the Earth's crust. Because of its high concentration and the magnetic property of its oxide minerals – particularly magnetite – the exploration and mining of Fe is easier than other base metals. One of the important features of iron ore is the presence of penalty elements, such as phosphorous (P) and aluminum (Al).

Application

Portable x-ray fluorescence (XRF) instruments are successful in the exploration and mining of iron ore deposits, as well as in grade control of the penalty element concentrates. Because P and Al are considered light elements, the need for a more sensitive analysis is required. With Thermo Scientific portable XRF analyzers, users are able to use its "Light Filter" ability, which is specifically designed to analyze these light elements.

Portable XRF Analyzers

Portable XRF is a technique that provides the ability to deliver fast and accurate results with little or no sample preparation in various stages of mining activity – from grass root exploration to ore grade control, and even environmental investigations.

More than 3,000 Thermo Scientific portable XRF instruments are used extensively in the mining industry worldwide, analyzing a broad range of elements from magnesium (Mg) to uranium (U). In particular, the handheld Thermo Scientific Niton XL3t GOLDD+ Series analyzer delivers fast, accurate elemental analysis with unmatched efficiency for companies across all stages of mining and exploration.

Also available are Thermo Scientific sample collection and preparation tools, which deliver a full lab-to-field solution for on-site XRF analysis. These compact, portable, battery-powered tools provide everything required to handle the sample collection and preparation of geological material for rapid elemental analysis in the field.

Figure 1. RC pulp sample is lightly pressed to make a flat surface for analysis.

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Methodology

Thirty five reverse circulation (RC) samples were analyzed using a Niton® XL3t XRF analyzer. Commonly, in an RC drill, a pneumatic reciprocating piston (hammer) drives a tungsten-steel drill bit, which through the help of an air compressor drying the material out, produces rock chips that are returned to the surface. Sample preparation, including crushing and pulverizing, eliminates effects of sample heterogeneity and improves the accuracy of portable XRF data. For this study, each sample was analyzed both in RC piles (chips are variable in grain size – starting at 10 mm in diameter) as well as in pulp specimen (see Figure 1).

Because analysis is performed by making direct contact with soft samples, the reading window was checked for any contaminants following a detector calibration. An SiO_2 blank standard was analyzed using Soil Mode, which measured a range of elements from chlorine (Cl) to U. Any significant readings of elements in this range would identify contaminants on the window. Samples were analyzed for 40 seconds ("Main" and "Low" filters for 10 seconds each, and 20 seconds for the "High" filter).

Results

The coefficient of determination, the R^2 value, is a measure of how closely the data sets correlate to each other. A perfect correlation would have an R^2 value of 1. This study shows a high correlation between the Niton XL3t analyzer data and the lab data for Fe, manganese (Mn), and titanium (Ti), as well as penalty elements, Si and Al (see Figures 2-4, Table 1). P concentrations were below detection limits in the analyzed samples. This investigation also indicates the importance of sample preparation in improving accuracy and precision of the portable XRF assay. For example, correlation with lab data increased from 0.8910 in the piled samples to 0.9957 in the prepared, pulp specimen. Similar improvements are seen in the penalty elements as well.

Sample Type	Fe	Mn	Ti	Si	Al
Pile	0.8910	0.6912	0.9388	0.8251	0.8453
Pulp	0.9957	0.9976	0.9892	0.9903	0.8945

Table 1: Correlation (R^2) between assay data from Thermo Scientific Niton XL3t XRF analyzer and lab.

Conclusions

The results yielded by both the RC sample piles and the pulps show strong correlations between the portable XRF results and the lab data, which indicates that portable XRF is a reliable, fast, and effective tool for iron ore grade control and mining. Such real time data can be crucial in helping geologists to make decisions in the field, saving time and money. The improved correlation data for the RC pulp data versus the RC sample piles data set suggests that better accuracy and precision can be achieved through better sample preparation. The fewer variables in the samples, the less error there will be in the assay data. Our sample preparation tool kits can be utilized to obtain pulverized specimen from a variety of geological samples ranging from chip rock to drill cores.

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

Thirty five reverse circulation (RC) samples were analyzed on site using a Thermo Scientific Niton XL3t XRF analyzer.

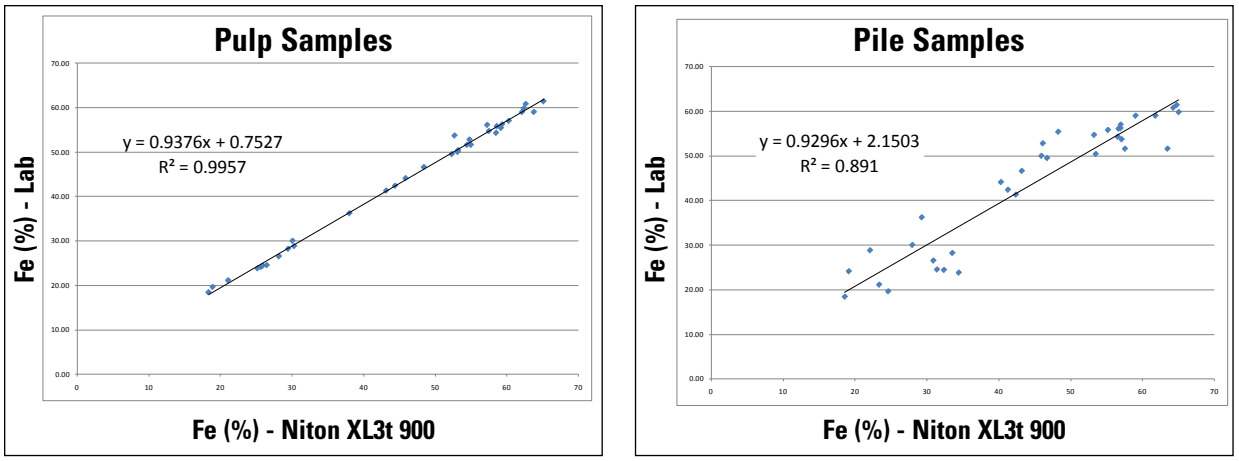


Figure 2. Correlation between Fe values measured by portable XRF and lab in the pile and the prepared pulp samples. Note significant improvement in R^2 value in the prepared pulp samples.

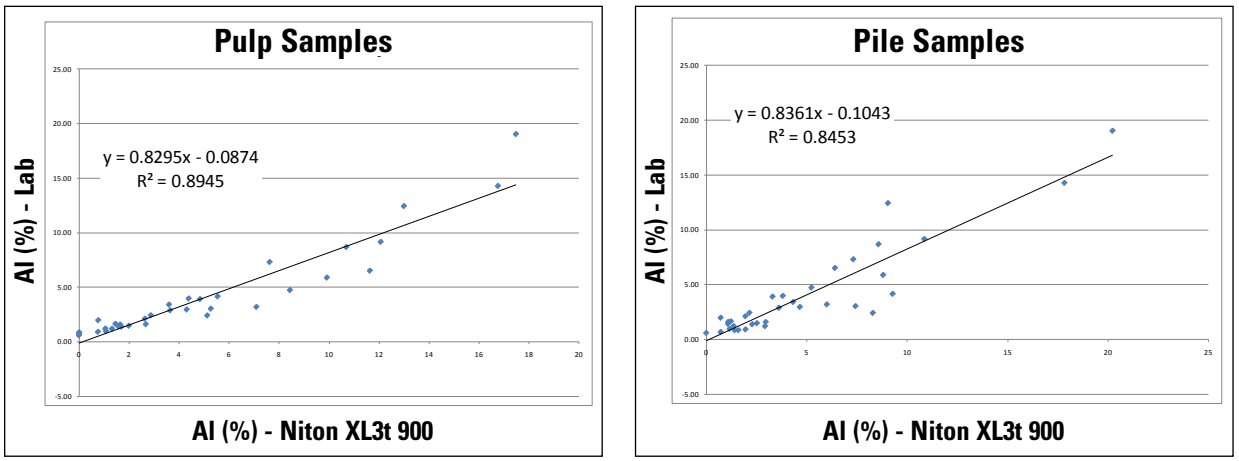


Figure 3. Correlation between Al values measured by portable XRF and lab in the pile and the prepared pulp samples.

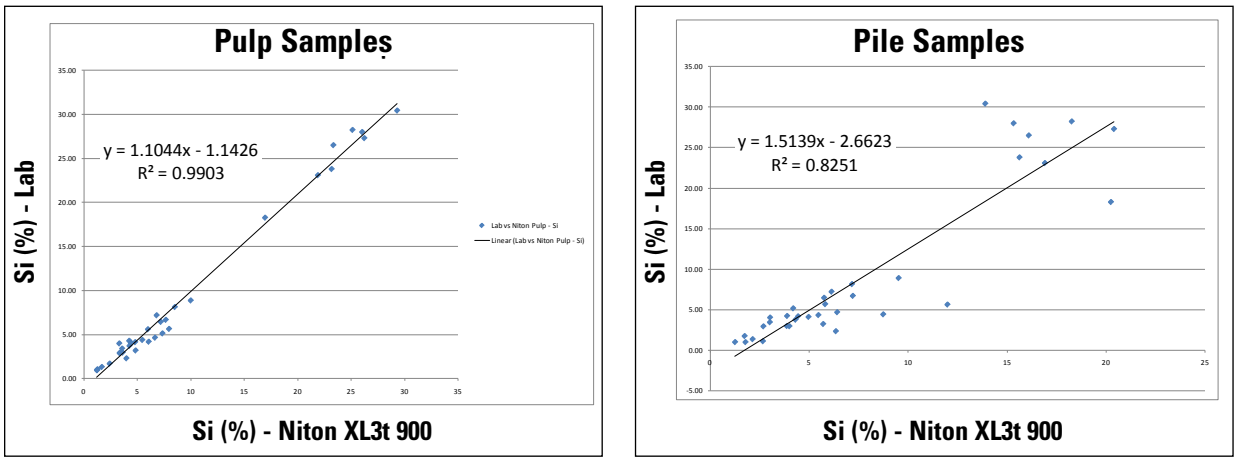
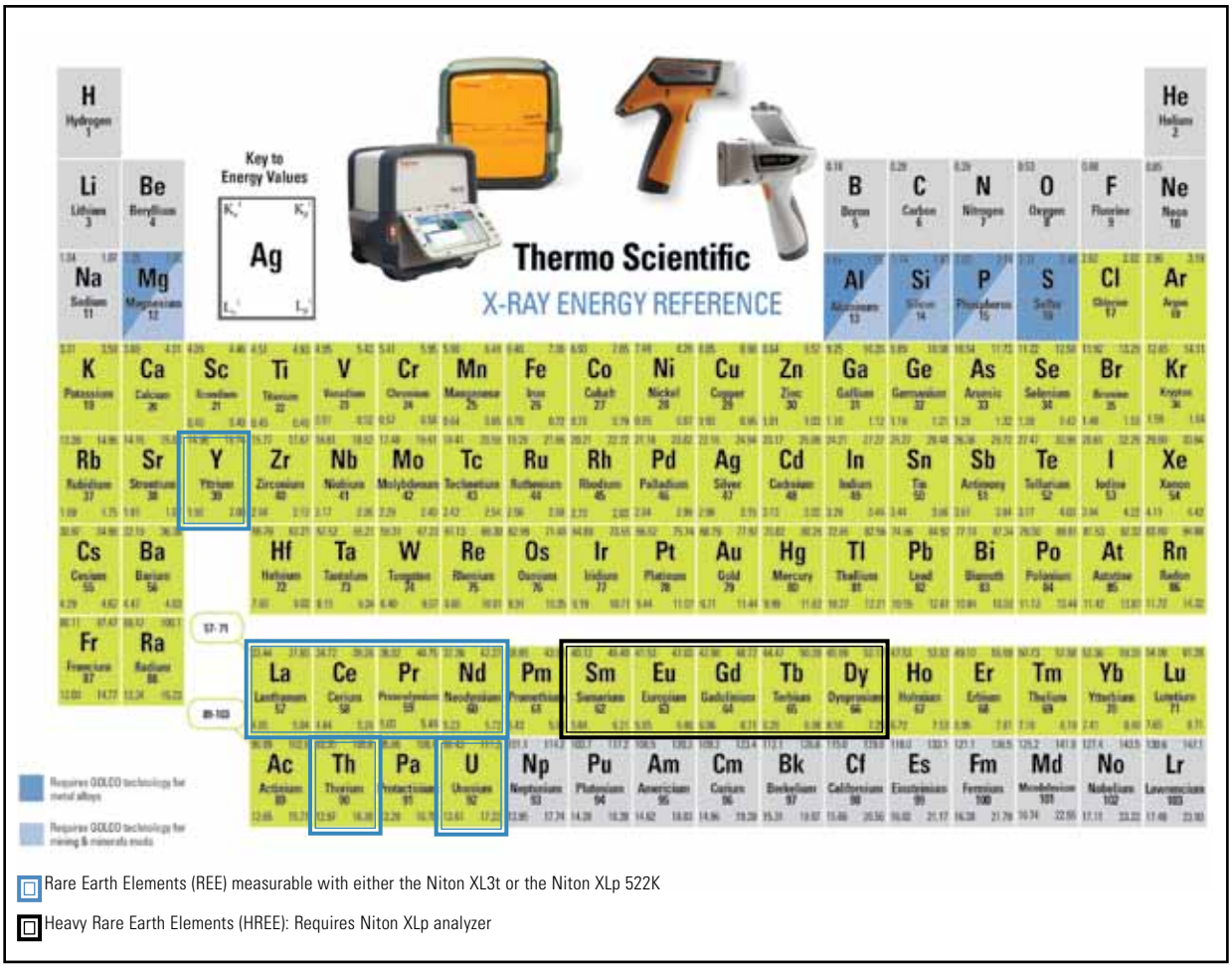


Figure 4. Correlation between Si values measured by portable XRF and lab in the pile and the prepared pulp samples



Rare Earth Elements (REE) measurable with either the Niton XL3t or the Niton XLp 522K

Heavy Rare Earth Elements (HREE): Requires Niton XLp analyzer

Thermo Scientific Niton XRF analyzers are the ideal choice for measuring both light and heavy rare earth elements as well as providing reliable results for a comprehensive range of key element groups for mineral exploration.

In addition to these offices, Thermo Fisher Scientific maintains a network of representative organizations throughout the world.

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