# Use of Thermo Scientific Portable XRF Analyzer in Mn-Fe Exploration and Mining

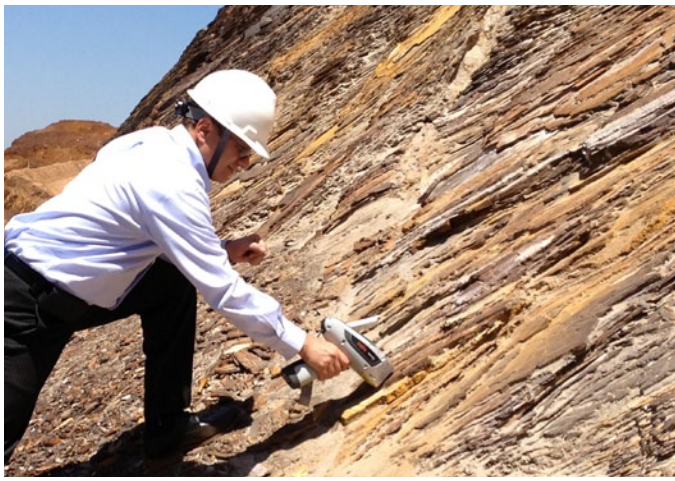
Application Note

## Introduction

Manganese (Mn) is not a rare metal as it makes up about 0.1% of the earth's crust. Also average Mn in soil is about 440 ppm (ranges from 7 to 9000 ppm depending on soil type). These concentrations are much higher than the detection limit of Mn; therefore, Mn can easily be detected by Thermo Scientific portable XRF analyzers.

Manganese ores usually consist of dark brown to black oxides particularly pyrolusite ($MnO_2$) and psilomelane ($BaMn_9O_{18}$ $2H_2O$). Manganese carbonate (rhodochrosite, $MnCO_3$) and silicate (braunite, $MnSiO_3$) may occur locally. All manganese minerals usually show a close spatial relation to the iron ores.

Manganese is mined in countries such as South Africa, Australia, China, Brazil, Gabon, Ukraine, India, Ghana and Kazakhstan.



The Thermo Niton XL3t Ultra being used on a world-class banded iron formation (BIF) in Brazil.

## Field Portable XRF Analyzers in Mining

X-ray fluorescence 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 field portable XRF (FPXRF) analyzers used extensively throughout the global mining industry. A broad range of elements from magnesium (Mg) to uranium (U) can be analyzed using these instruments.

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

### Application

Manganese is very similar to iron in its chemical properties. As a result, Mn accompanies iron ores and, commonly in small amounts, substitutes Fe in iron minerals. There are several types of Mn deposits worldwide: Precambrian manganese-formations (older than 541 million years), black shale-hosted Mn-carbonate deposits, shallow marine deposits, high-grade ores developed from low-grade ore (supergene deposits), and manganese crusts and nodules. It is notable that several billion tons of manganese nodules are estimated to exist on the ocean floors which are not being mined.

More than 90% of the world's Mn consumption is in the steel industry to form an alloy called ferromanganese. Also it is used in the chemical industry; for example as potassium permanganate for water treatment and purification, and as Mn dioxide in dry cell batteries.

### Method

This case study was carried out using a Thermo Scientific Niton XL3t GOLDD with a Mining Mode calibration for total time of 90 seconds (30 s Main filter and 20 s for other filters). 33 Fe-Mn ore samples from a Fe-Mn mine site were analyzed. Fourteen of these samples had lab assays that are used here for comparison purposes.

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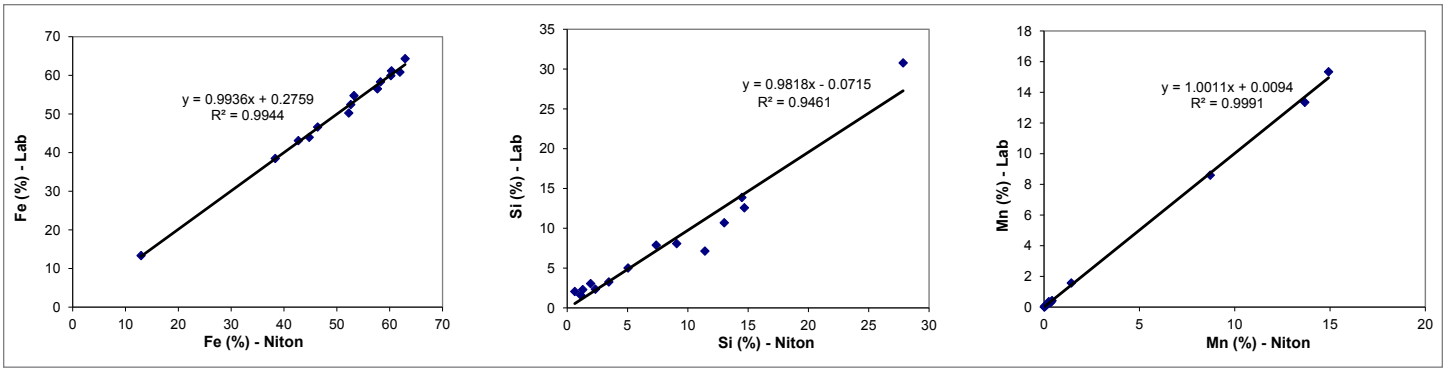


Figure 1. Correlation of Fe, Mn and Si data between portable XRF and lab in Fe-Mn ore samples.

Concentrations of Fe, Mn and Si (as a light element) in these samples, along with correlation with lab assay data, are shown in Figure 1.

Also one of the samples was analyzed 8 times under the same conditions to evaluate repeatability (precision) of the assay. The results are shown in Figure 2.

## 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 Fe and Mn was very strong with a $R^2$ of more than 99%. For Si the $R^2$ was 95% (see Figure 1). Also the assay data show high precision testified by very low relative standard deviation (RSD) of 0.386% for Fe and 0.270% for Si.

## Conclusion

The field portable x-ray fluorescence spectrometer has significantly evolved over the past 10 years to become an indispensible and very productive geochemical tool. Portability, ease of use, and the ability to produce real time nondestructive elemental analyses (about 30 elements from Mg to U) make FPXRF a dynamic field instrument that can help geologists make timely process or planning decisions. It 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). The high threshold concentration of Fe and Mn in natural samples supports the application of this technique in Fe-Mn exploration and mining, providing high accuracy and precision data.

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.

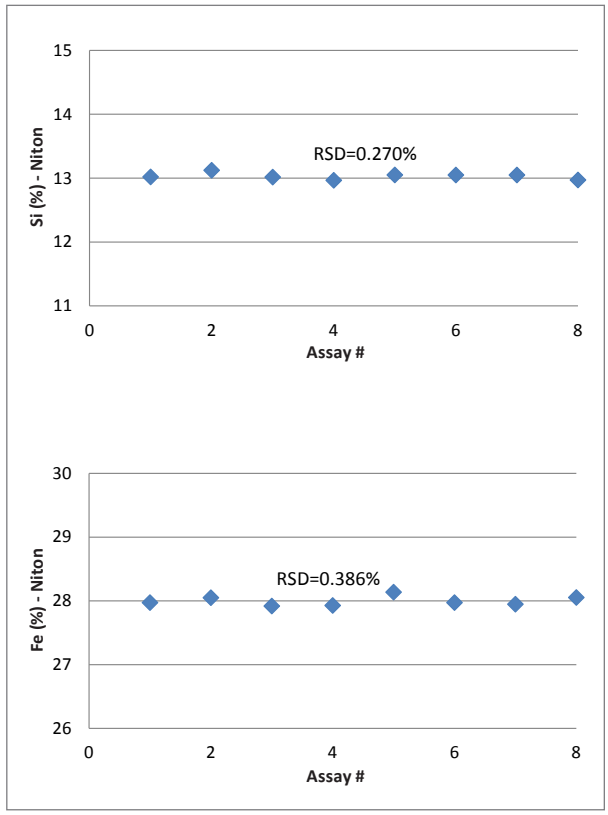


Figure 2. Repeatability (precision) of Fe and Si assays was tested by analyzing one sample 8 times.

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5-334 11/2013