Application of the Thermo Scientific Portable XRF Analyzer in PGE Exploration

Example from the Merensky Contact Reef, Bushveld Complex, South Africa

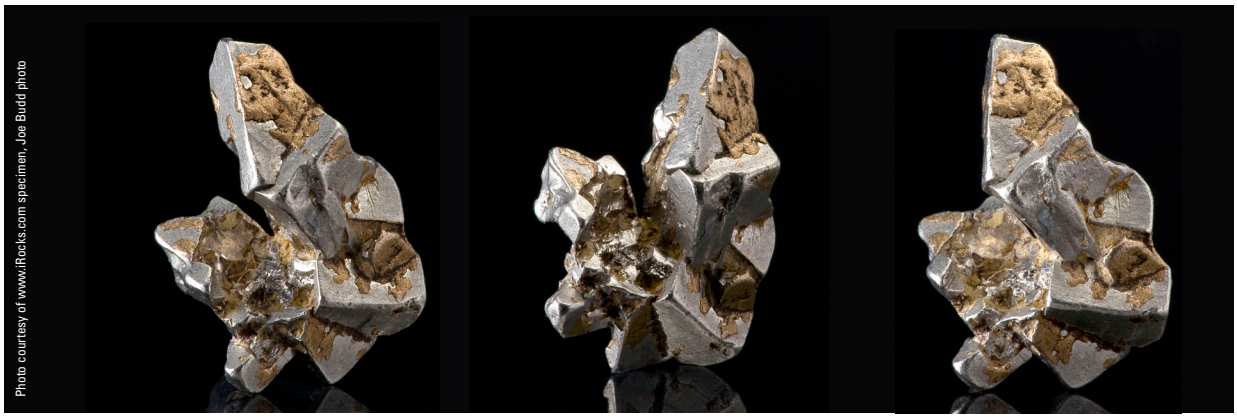


Photo courtesy of www.iRocks.com specimen, Joe Budd photo

Introduction

Mining and exploration activities for precious metals have risen due to both high prices and increased demand. Precious metals is a collection of valuable metals that includes gold, silver, and the platinum group elements (PGEs). In most instances – such as mining, ore grade control, and exploration of rich zones – precious metals can be detected directly. In other occurrences – where very low concentrations of these metals are under exploration – pathfinder elements, which can be enriched with precious metals, are used to locate potential zones. These pathfinder elements have a genetic relationship with the precious metals, and, therefore, can successfully be used as exploration tools.

"...it is possible to successfully locate zones of high concentrations of precious metals (Pt, Pd, and Au, in this case) by using portable XRF on pathfinder elements."

Application

Pathfinder elements are very important in facilitating the exploration of various types of ore deposits including precious metal mineralization. Commonly, pathfinder elements have one or a few of the following criteria:

- They are detected relatively easily compared to the target elements.
- They are present at higher concentrations than target elements.
- They have a genetic relationship with the target elements. This means that both groups of elements (target and pathfinder) originate from the same source or were deposited at the same time and place
- In most cases, pathfinder elements have a larger halo (due to higher mobility) than target elements. This means that pathfinder elements occur in a larger area than the target elements, and, as a result, the halo of pathfinder elements is used as a vector toward the target elements' mineralized zone (see Figure 1, next page).

The type of pathfinder elements depends on the target element and deposit type/style. Preliminary investigation should be carried out in each area to find suitable pathfinder elements. In precious metal exploration, a high correlation between the target element and a given element "X" (based on the laboratory assays) may show that element X can be used as a pathfinder in fieldwork using portable x-ray fluorescence (XRF).

Benefits At-a-Glance

- 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

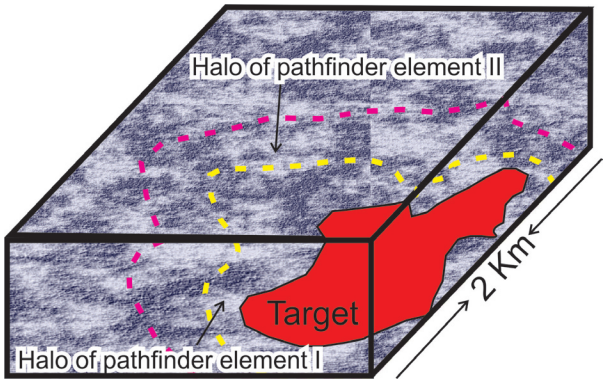


Figure 1. Schematic showing the spatial relationship between target (ore zone) and two hypothetical pathfinder elements I and II. Note the larger size of the pathfinder elements' halos.

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, 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 with Thermo Scientific geometrically optimized large area drift detector (GOLDD) technology for more than 25 elements, including light elements (Mg-S)

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.

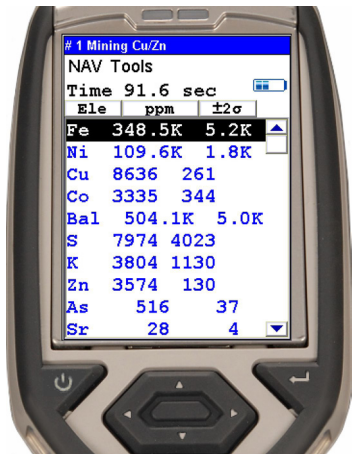
Methodology

The target area in the Bushveld Complex in South Africa is the Merensky Reef, a layer of igneous rock, which, together with an underlying layer, the Upper Group 2 Reef (UG2), contains most of the world's known reserves of PGEs. In the studied area, the stratigraphy includes pyroxenite, anorthosite, and harzburgite (pseudo/altered) with local strings of chromite. The PGEs are hosted in disseminated sulphides with typical grades ranging from 3 to 10 g/t (ppm). Locally, PGEs are hosted in the finely disseminated sulphide grains in the chromite-rich lithologies. Mining is conducted in the Bushveld Complex for all six platinum group elements (platinum, palladium, rhodium, ruthenium, iridium, and osmium) as well as gold, nickel, and copper.

To investigate the application of portable XRF in PGE exploration in the Bushveld Complex, 63 samples were collected along a stratigraphic section. The samples then were analyzed by a commercial lab (SGS-Lakefield) using ICP. Two types of Thermo Scientific portable XRF analyses (direct shot on the sample and pulverized sample-pulp) were carried out on these samples.

Results

Using lab assays, pathfinder elements were selected based on their correlation with the target elements (Pt, Pd, and Au, in this case) as shown in Figure 2. Visual examination of Pt-Au and Pt-Pd diagrams indicate positive correlations between Pt, Pd, and Au, which suggests that they can be found in the same or close stratigraphic units. Also, positive correlation in



Analysis of PGE pathfinder elements (Ni and Cu from this case study) using the Thermo Scientific Niton XL3t GOLDD+ XRF analyzer.

Thermo Scientific portable XRF analyzers deliver fast and accurate analysis of pathfinder elements for precious metal exploration.

Ni-Pt and Cu-Pt diagrams shows that Ni and Cu can be used as pathfinder elements not only for Pt, but also for both Pd and Au. Note that this approach is necessary to determine pathfinder elements.

In the next step, distribution of both target and pathfinder elements along the sampled stratigraphic section is investigated (see Figure 3, next page). Both target and pathfinder elements clearly show the same or a very similar stratigraphic-geochemical pattern. Note that even direct-shot assays of Ni and Cu using Thermo Scientific portable XRF analyzers can be used to locate zones of high Pt, Pd, and Au concentrations.

Conclusions

Exploration of precious metals is very challenging because the cut-off grade continues to decrease with time, as the value of the metals increase. This emphasizes the need for new and fast techniques for increasing productivity and efficiency in the field.

This study shows that it is possible to successfully locate zones of high concentrations of precious metals (Pt, Pd, and Au, in this case) by using portable XRF on pathfinder elements. These are the zones that should be sampled and assayed by lab methods for very low concentrations (sub-ppm levels) of precious metals – saving time and money in the field to locate these zones, and subsequently, in analyzing the right samples (not barren specimens). Such real-time access to assay data helps geologists make on-the-spot decisions and proficiently manage their mining projects.

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.

Note: Platinum and gold, two precious metals, are shown in the front page photo.

We would like to thank Boynton Platinum (Platmin Limited) for its technical and geological support.

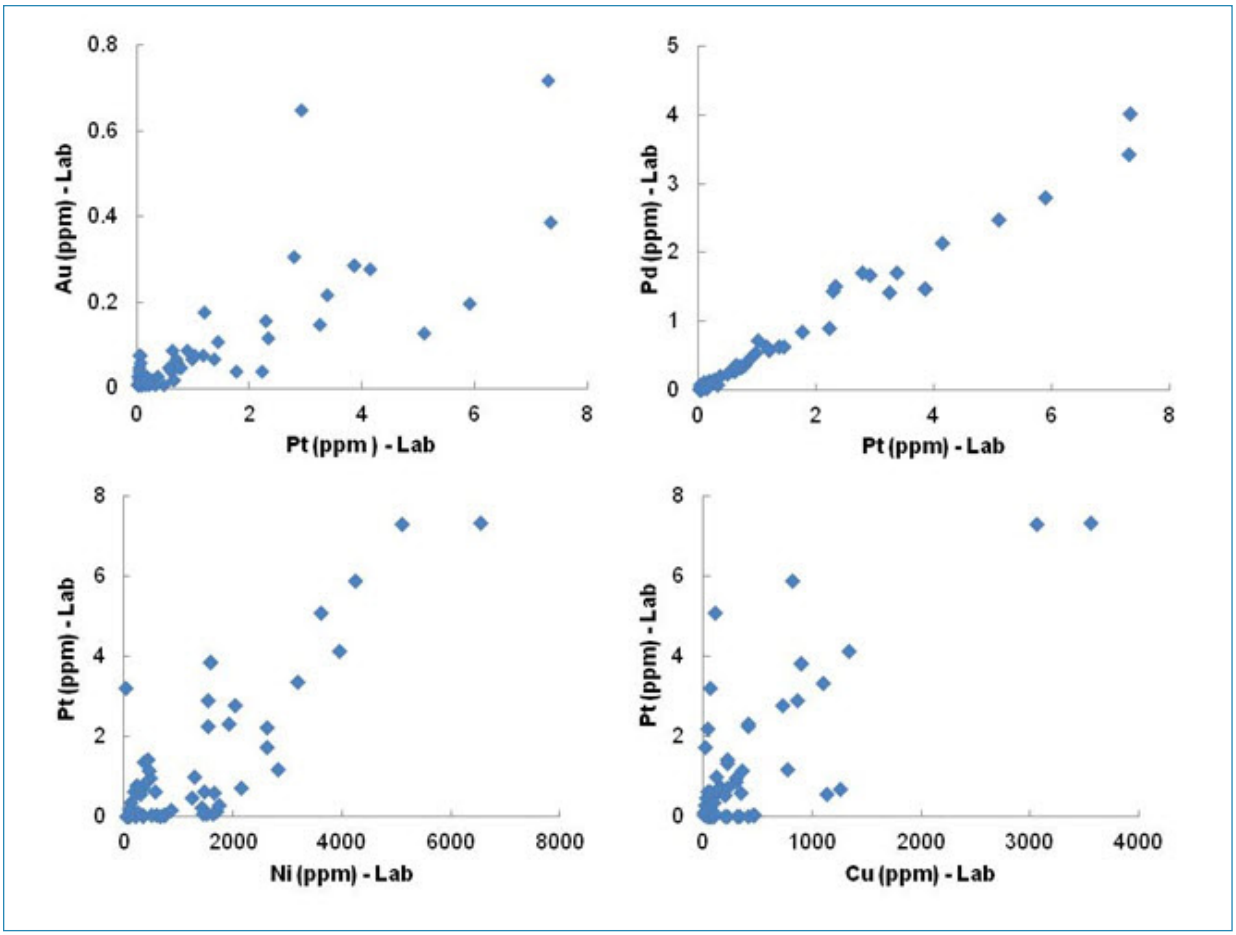


Figure 2. Positive correlation between target elements (Pt, Pd, Au) and potential pathfinder elements (Ni, Cu) based on lab assay data.

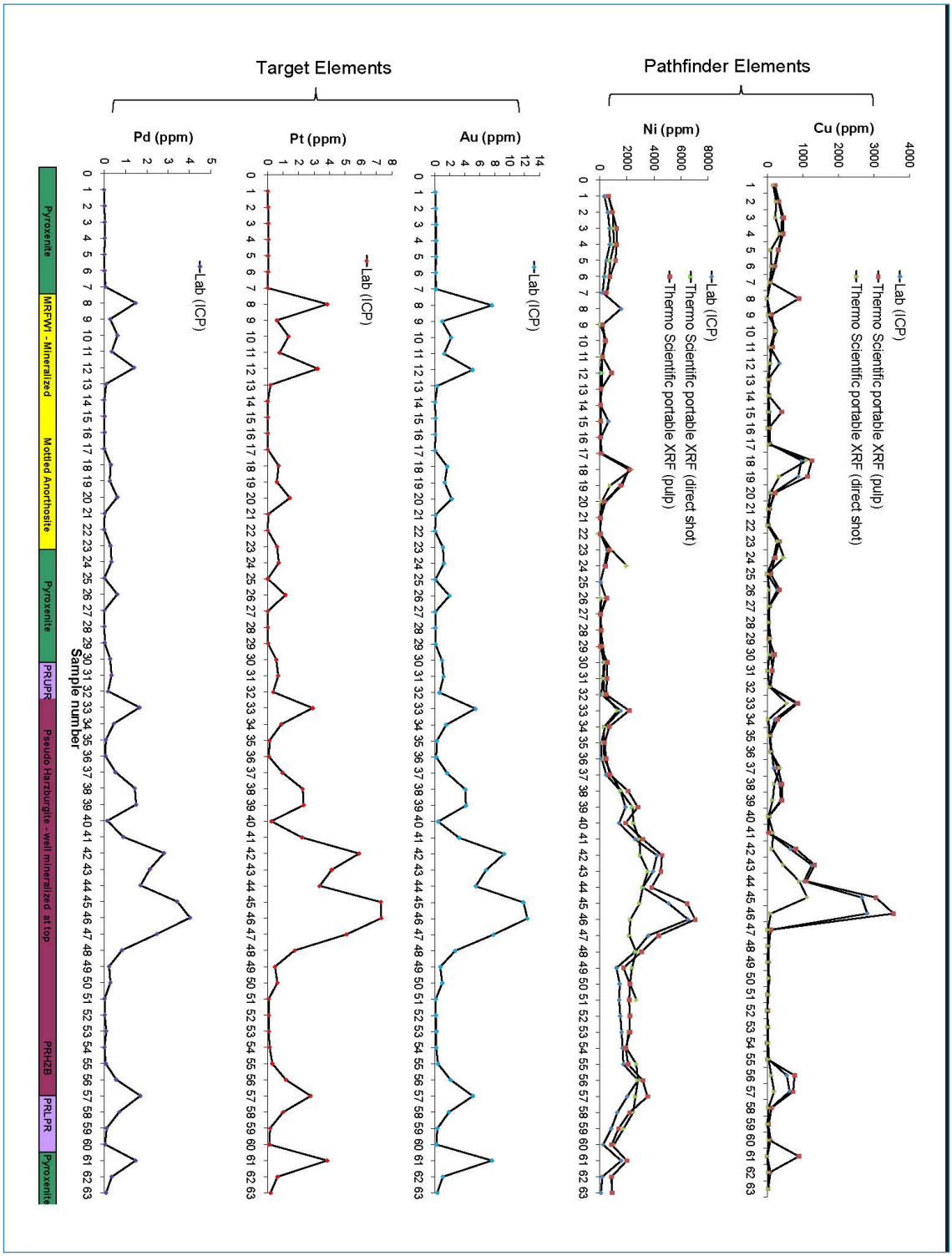


Figure 3. Stratigraphic distribution of target (Pt, Pd, Au) and pathfinder elements (Cu, Ni) in the Bushveld Complex, South Africa, which shows Cu and Ni assays using the Thermo Scientific portable XRF analyzer can be used to locate Pt, Pd, and Au mineralized zones.

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