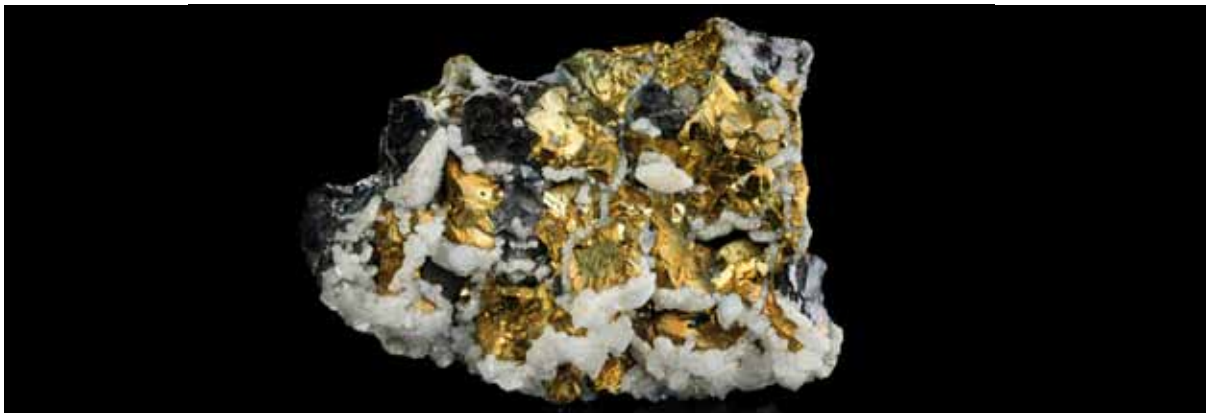
Identification of Lithology & Base Metal Anomalies – Pathfinders for Gold Exploration Using Thermo Scientific Portable XRF Analyzers

Example from the Blackwater Gold Deposit, British Columbia, Canada



Introduction

Throughout history, gold (Au) has been a very valuable metal because of its monetary worth and unique physical and chemical properties; it is chemically stable (does not oxidize, unlike other metals) and has high electrical and thermal conductivity. Geologically, Au is one of the rare metals in the earth's crust [0.0031 g/ton[1], compared to copper (Cu) 68 ppm, zinc (Zn) 79 ppm, lead (Pb) 10 ppm]. As a result, Au mining is economic at much lower concentrations than other metals.

Gold exploration and mining attracts more market capital than any other metal. However, Au exploration is very challenging because its economic mining threshold is low, and it depends on the tonnage available. For example, Au concentrations at even less than 1 g/ton can be economic in some large deposits. Geophysical and geochemical methods of Au exploration have advanced enormously in the last decade. Some common geophysical methods that are used to map hydrothermal alteration zones include airborne gravity, 3D modeling of electrical data, and infrared spectroscopy (satellite, airborne, and field-based). Although these geophysical methods are very crucial for gold exploration, geochemical methods – including portable x-ray florescence (XRF) – remain as the only methods that can measure concentration of gold and other associated elements.

Application

Gold is mined as a primary product or as a by-product from a wide range of deposits. Its deposits are classified into three major classes:

1. Orogenic vein-type deposits formed during orogenic events
2. Reduced intrusion-related Au-Bi-Te-As mineralization in post-orogenic granitic intrusions
3. Oxidized intrusion-related deposits (porphyry, skarn, and high-sulfidation epithermal (see Figure 1) associated with high-level, oxidized porphyry stocks in magmatic arcs

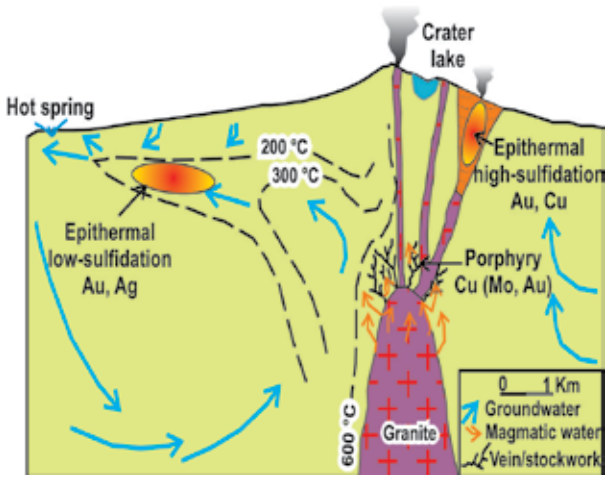


Figure 1. Epithermal gold deposit model showing spatial relationship between low- and high-sulfidation epithermal mineralization with porphyry copper and intrusion.

[1] *1 ppm = 1 g/ton*

The Thermo Scientific Niton XL3t GOLDD+ XRF analyzer is used to not only identify gold grains, but also to quantify them.

Carlin, low-sulfidation epithermal, Au-rich volcanogenic massive sulfide (VMS), and Witwatersrand deposits are also important gold deposit types.

Portable XRF Analyzers

Thermo Scientific portable XRF analyzers can be used in any stage of exploration, mining, and ore processing of various metals from Au to silver (Ag), Cu, molybdenum (Mo), Pb, Zn, antimony (Sb), bismuth (Bi), etc. Detection limits for base metals in these instruments are low enough to allow even non-geologists to analyze any geological sample from outcrops to drill cores and soil specimens. In addition to precious and base metals, other elements, such as potassium (K), calcium (Ca), titanium (Ti), and light elements [magnesium (Mg), aluminum (Al), silicon (Si), phosphorus (P), and sulfur (S)] can be assayed as well. This helps geologists in mapping the hydrothermal alteration of the exploration/mining area or with 3D modeling of the alteration and mineralization.

Methodology

The Blackwater Gold Project is located approximately 160 km southwest of Prince George in central British Columbia, Canada. At this site, geochemical anomalies of Zn were first discovered in stream sediment samples in 1973. Since then, extensive soil geochemistry, geophysic testing, and diamond drilling have been carried out in the area.

Bedrock exposures in the immediate area of the Blackwater mineral deposit are sparse due to extensive, post-mineral glacial till cover, ranging from a few to several tens of meters in thickness. Host rocks include intercalated, volcanic and volcaniclastic felsic to intermediate tuff, volcanic breccia, and andesitic flows. These rocks form a local wedge of laterally discontinuous strata believed to dip generally northwest. Steeply dipping faults bound the wedge to the west and to the north, suggesting that the Blackwater block is a horst or high-standing remnant. Low-grade, disseminated Au and Ag mineralization occurs in these volcanic rocks. They are extensively hydro-fractured and silicified and contain fine-grained sulfides throughout the silicified quartz-sericite breccias.

Gold mineralization occurs as low-sulfidation epithermal style disseminated and stockwork sulfide veining (pyrite + sphalerite > pyrrhotite > chalcopyrite > arsenopyrite > tetrahedrite). Gold is mainly associated with the sulfide minerals and occurs as native grains between 5 and 50 microns across.

Richfield Ventures Corp. discovered and explored the property, which was taken over by New Gold, Inc. in 2011. During Richfield's daily drill work on the property, a Thermo Scientific Niton XL3t Series XRF analyzer was used. The analysis results helped the company gain immediate quantitative data on the core to aid in drilling decisions. Core samples were spot analyzed every 30 to 50 cm in core boxes. Every analysis was taken with "Main" and "Low" filters on for 15 seconds each. There was no sample preparation work done on the samples. One dedicated operator kept up with the drill. Conventional sampling of core at one meter intervals was also undertaken with analysis by a commercial analytical lab.

Results

Strip logs were plotted to compare the analytical results from the lab with the XRF results using assay data from the commercial lab, as well as on-site, direct analysis using portable XRF (see Figures 2 and 3). These strip logs demonstrate good correlation between lab and portable XRF data, and the efficiency of portable XRF in definition of

various lithologies. In addition, portable XRF is a good method to investigate unknown minerals (including fine-grained gold which can be mistaken for pyrite or chalcopyrite) or to compare bulk chemical compositions of clasts and crystals.

Conclusions

Gold exploration is challenging because it is one of the rare metals found in the earth's crust. Geochemical analyses, such as portable XRF, are the only methods that can measure gold concentrations. This application note summarizes the successful use of portable XRF analysis as a direct check on the identification of lithology and base metal anomalies used in gold exploration:

- Portable XRF compares well with lab results for most metals, including economic metals – Cu, Pb, Zn, and Mo.
- Portable XRF provides clear chemical definition of rock units on the basis of major elements – Ti, Ca, Fe, Mn, and K.
- Portable XRF can be used on pathfinder elements for gold – Zn, Pb, Cu, and As.

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.

Acknowledgments

We would like to thank Richfield Ventures Corp., especially Dr. Dirk Tempelman-Kluit for his technical and geological support.

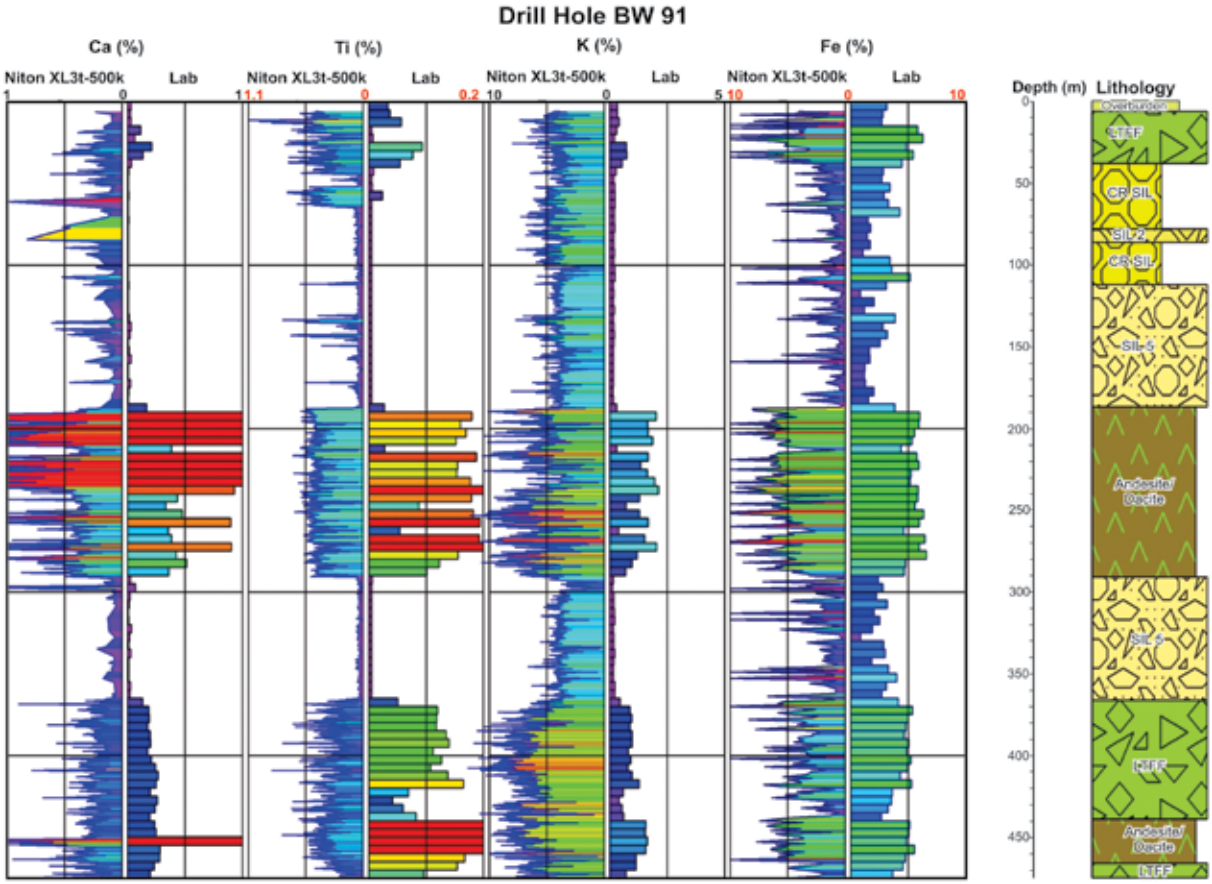


Figure 2. Strip logs for drill hole BW 91 shows a distinct geochemical signature of various lithologies.

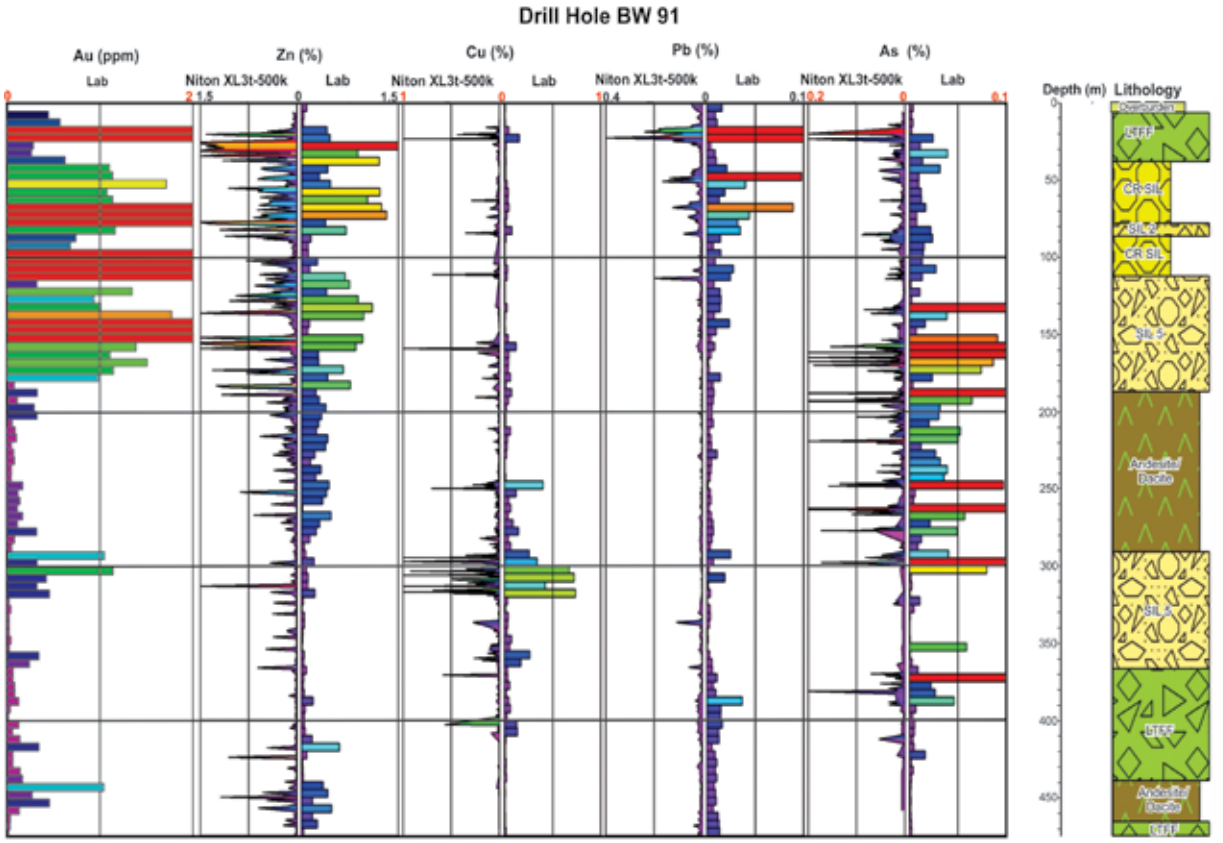


Figure 3. Strip logs for drill hole BW 91 shows good correlation between anomalous zones of Zn, Cu, Pb and As based on data from lab and portable XRF. Note that Zn is the best pathfinder element for Au.

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