Application Note

Handheld XRF analysis

Measuring Rare Earth Elements in geological samples using the Niton XL5 Plus handheld XRF Analyzer

Introduction

Rare earth elements (REEs) include, according to the nomenclature of the International Union of Pure and Applied Chemistry (IUPAC)[1], scandium (Sc), yttrium (Y) and the lanthanide series of elements, i.e. elements in the periodic table from lanthanum (La), atomic number 57 to lutetium (Lu), atomic number 71.

Rare earth elements are vital for manufacturing numerous materials such as permanent magnets, industrial and automotive catalysts, glass polishing powders, glass additives, metals and alloys, battery alloys, ceramics, pigments, or phosphors.[2] Various technologies use these materials in renewable energies, low energy lighting, emission control, electronics, medical, military, lasers, superconductors, and many other high-tech applications. [3]

With the notable exception of promethium (Pm), RREs are naturally occurring elements. They are, despite their name, elements that can be relatively abundant in the earth's crust: cerium (Ce), yttrium (Y), and lanthanum (La) are present at average concentrations of respectively 66, 39, and 33 parts per million (ppm), comparable or higher than copper (60ppm) and lead (14ppm).[4] Other REEs typically occur between levels of 0.5 and 10 ppm, which is significantly higher than the average gold (0.004 ppm) or silver (0.075 ppm) concentrations.[4]

Despite their relatively high concentration in the earth's crust, REEs are rarely concentrated into mineable ore deposits. In fact, REE ores are mineralogically and chemically complex. Thus, REE mining is challenging because REEs are abundant in more than one mineral, and each mineral requires a different and costly extraction technology and mineral processing

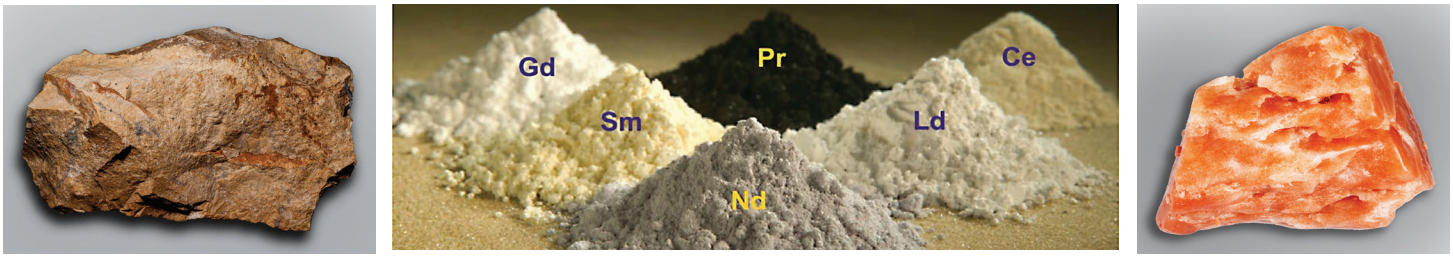

Figure 1. Bastnäsite (left) and Monazite (right) minerals are the largest sources of Rare Earth Elements.

technique.[5] Moreover, REE ores often contain thorium (Th), a radioactive element that creates radioactive waste and causes an additional cost of handling. Therefore, rare earth element deposits where REEs are heavily concentrated in a single mineral phase have a competitive advantage. To date, REE production has primarily come from single-mineral-phase deposits, such as Bayan Obo (Bastnäsite), Mountain Pass (Bastnäsite), and heavy-mineral placers (Monazite).[5] In 2020, China produced about 60% of REE supply. While Australia, Myanmar, and India produced the remainder.[6]

For companies operating in REE exploration and mining worldwide, the accuracy of geochemical analysis is critical to assess the viability of deposits, respectively targeting REE-rich areas for extraction. The Thermo Scientific™ Niton™ XL5 Plus handheld XRF analyzer brings lab-quality geochemical analysis of primary elements and REEs to the field.

Niton XL5 Plus Handheld XRF Analyzer

The Niton XL5 Plus analyzer is the smallest, lightest, and most powerful handheld XRF analyzer, making the technology easy to carry and deploy in the most remote places. The Niton XL5 Plus analyzer is equipped with compact measurement geometry, a robust 5W X-ray tube operating up to 50kV at 100 µA and down to 6kV at 500µA, and the latest silicon drift detector technology with a large area and graphene window. These integrated features provide optimal performance and unprecedented heavy and light element sensitivity for the most demanding applications, such as measurements of rare earth elements.

Figure 2: The Niton XL5 Plus analyzer standalone instrument (above). Instrument in a Mini Test Stand for sample cups and sample bags analysis (top right) and in reverse combination for direct soil analysis (bottom right).

The Niton XL5 Plus Rare Earth Element Mode covers an elemental range from magnesium to uranium, including light REEs such as lanthanum (La), cerium (Ce), praseodymium (Pr), and neodymium (Nd). Scandium (Sc) and yttrium (Y) have similar chemical properties. Usually, these elements occur in the same ore deposits as heavy REEs, making it possible to infer concentrations of heavier REEs from measured yttrium and scandium values. Measured element concentration can be quickly mapped using the integrated GPS or by connecting the Niton XL5 Plus analyzer with an external professional GPS. With an IP54 rating, the Niton XL5 Plus analyzer is splash proof, dustproof, and ideally suited for the rugged surroundings of exploration fields and mines.

Method

The collected samples from different Canadian mining companies were previously pulverized to a typical particle size of less than 250 µm and introduced into sample cups fitted with 4µm polypropylene film. The sample cups were then placed on a test stand. Then, analysis was executed using the Niton XL5 Plus Rare Earth Element Mode for 180s using four different primary filters and voltages to measure REE and concomitant elements from magnesium to uranium.

Results

The analysis results obtained for the set of samples are compared in figure 3. Two methods obtained the results: 1) round robins using multiple methods; 2) single lab analysis using ICP-OES and ICP-MS after preparing fused beads of the mineral samples and dissolving those in diluted acids. Strong correlations between the lab assays and measured values were apparent in the yttrium, lanthanum, and cerium results shown in figure 3. Also, the instrument's accuracy "out-of-the-box" is adequate and can be further improved by applying type standardization.

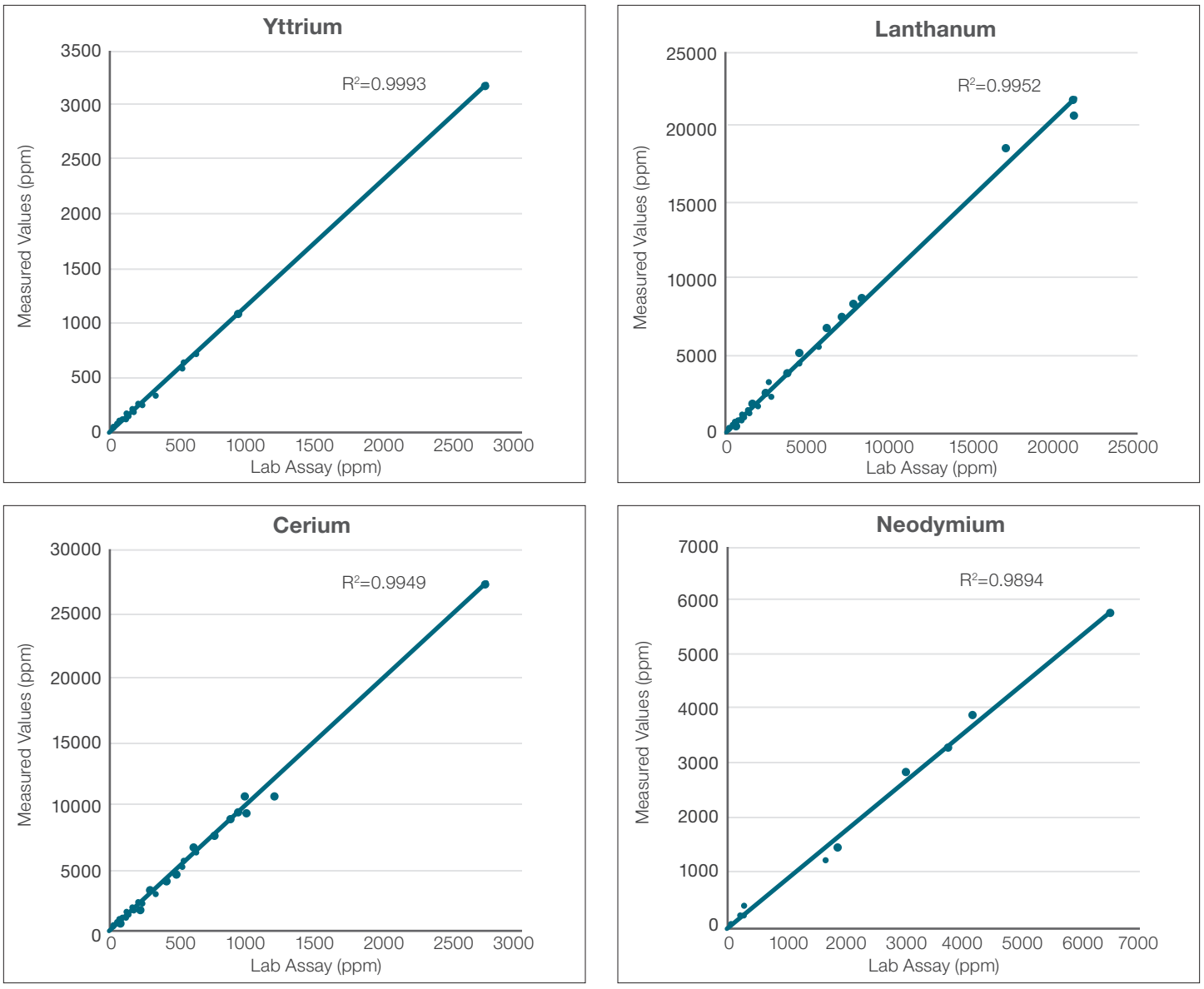

Figure 3. Exemplified lab values vs. measured values using the Niton XL5 Plus analyzer "out of the box" for the determination of REEs.

Conclusion

The Niton XL5 Plus analyzer's robust performance and unparalleled technology make instant high-quality geochemical data and a fast return on investment possible. The new Niton XL5 Plus Rare Earth Element mode empowers geologists and miners to target elements in complex minerals with unprecedented sensitivity. Localizing anomalies and identifying drilling targets, the Niton XL5 Plus analyzer is an indispensable tool to make informed decisions and accelerate REE exploration, considerably reducing lab analysis costs. The Niton XL5 Plus analyzer is a vital tool to guide REE extraction, find high-grade enrichments, and ascertain the viability of low-grade ores during the mining process.

References

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