Elvatech
Advanced XRF equipment and solutions

ElvaX ProSpector in Exploration & Mining

Introduction

ElvaX ProSpector is a fast, accurate and easy tool for different mining applications. It provides on-site analysis of ore samples with minimal sample preparation, reducing the time for lab assay from days to minutes. ElvaX ProSpector uses fundamental parameters method for ore sample analysis without the need of any calibration standards. However it is also possible to make fundamental parameters or empirical calibrations for more accurate analysis of certain ore types.

ProSpector LE is equipped with large area Silicon Drift detector, which performs analysis of light elements, such as aluminum, phosphorous, silicon without helium purge. Light elements analysis is very important for understanding sample mineralogy, and it is critical for analysis of certain types of minerals such as bauxite and limestone.

Application

ElvaX ProSpector can be used for on-site analysis at all ore processing stages.

- Exploration. ProSpector is good for fast screening of vast areas due to the light weight and mobility of the instrument.
- Mining. ProSpector provides easy ore grade control and allows you to make quick decisions.
- Processing. Analysis of ore concentrates during the enrichment process is also a simple task for ElvaX ProSpector. Both primary elements and trace elements can be accurately measured due using the fundamental parameters method.
- Geochemical mapping. ElvaX ProSpector offers wireless connection to external GPS systems and can store GPS coordinates with each measurement. GPS data can be imported to any GIS application for mine mapping. Example of mine mapping using ElvaX ProSpector is shown in Fig. 1.

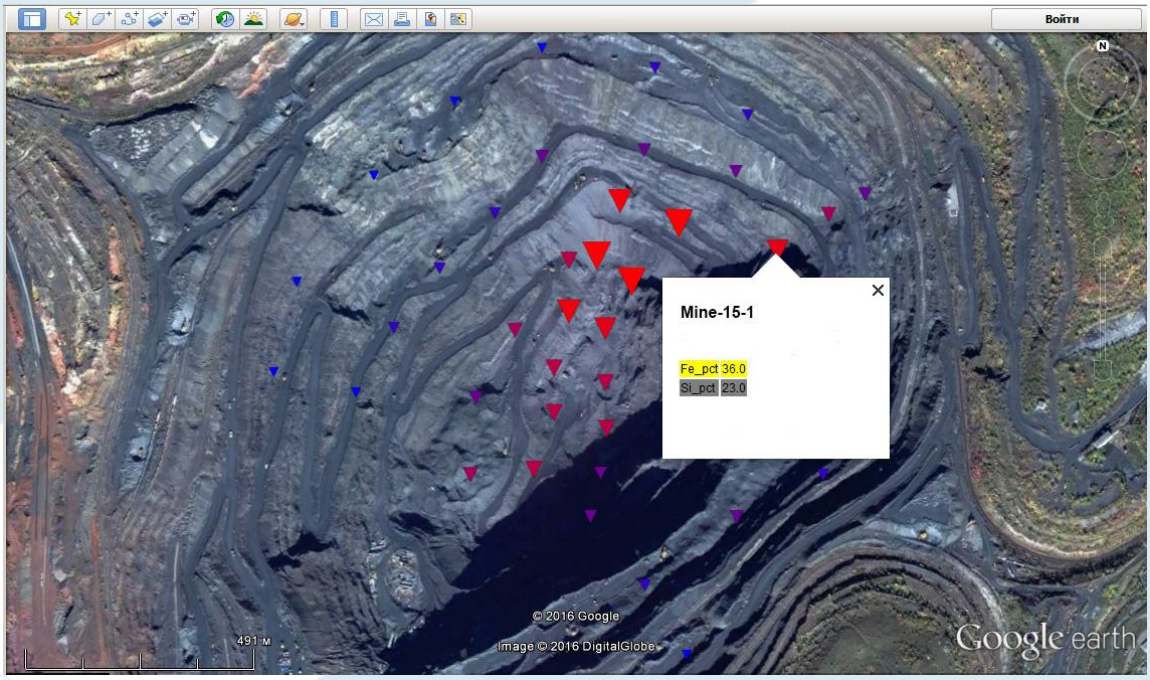

Figure 1. Geochemical mapping of iron ore mine.

Instrumentation

There are two models of ElvaX ProSpector: Standard Edition and Light Edition. Standard edition equipped with 40 kV Tungsten anode tube and Si-PIN detector and allows to determine elements from Cl to U.

For light elements analysis, including Mg, Al, Si, P, S ProSpector Light Edition is needed. It equipped with a 40 kV Rhodium anode tube, 5 different filters and high resolution large area Silicon Drift Detector (SDD), which provides excellent energy resolution, lower detection limits and shorter measurement times comparing with the standard edition.

ElvaX ProSpector is rugged and light (around 1.5 kg) and provides full-day (8 hours) of constant operations on battery. Device has intuitive user interface and requires very little operation training.

Typical measurement screen in tin ore mode is demonstrated at figure 2.

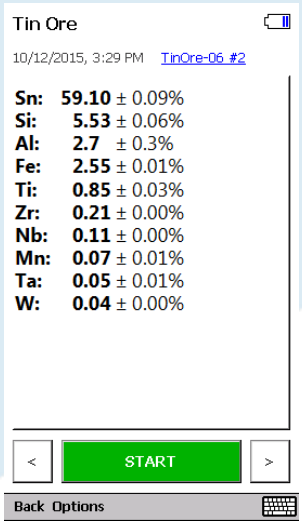

Figure 2. Tin ore testing screen.

Method

The majority of natural samples are heterogeneous. So, sample preparation before measurement is strongly recommended, especially for light element analysis. Samples must be crushed, ground, mixed and placed in 32mm XRF cups.

Six different types of ores and concentrates were analyzed with ElvaX ProSpector LE: iron, copper, chrome, lead, tin, silver and gold ores.

ProSpector LE has 2 main geology calibration modes: «Mining» mode and «Mining 2pass» mode.

In «Mining» mode only one pass with one beam settings (35 kV voltage) is used. It allows to determine elements from Cl to U in low concentrations (until ~15%). This mode is best for geoexploration and analysis of low grade ore. Advantage of this mode is absence of influence of LOI (loss of ignition) to measurement results.

«Mining 2pass» mode consists from two passes (35 kV and 12 kV voltages) and allows to analyze light elements (Mg, Al, Si, P, S). Mining 2pass mode is used for analysis of high grade ores, minerals and silicate materials. It is assumed that LOI is low in this mode.

For more deep analysis, LOI can be calculated using any other technique and then added to measurement result as undetectable element.

Results

Accuracy

Figures 3, 5-10 show the correlation curves between the lab results and those of ElvaX ProSpector.

Figure 4 shows the correlation curve for silicon dioxide content in iron ore, whose concentration determines quality of ore and melting process.
This data was approximated with a linear function.

R^2 is the coefficient of determination which shows how closely lab and XRF results correlate to each other. An ideal correlation would have an R^2 value of 1.

Obtained results indicate a good correlation between lab and measured concentration values.

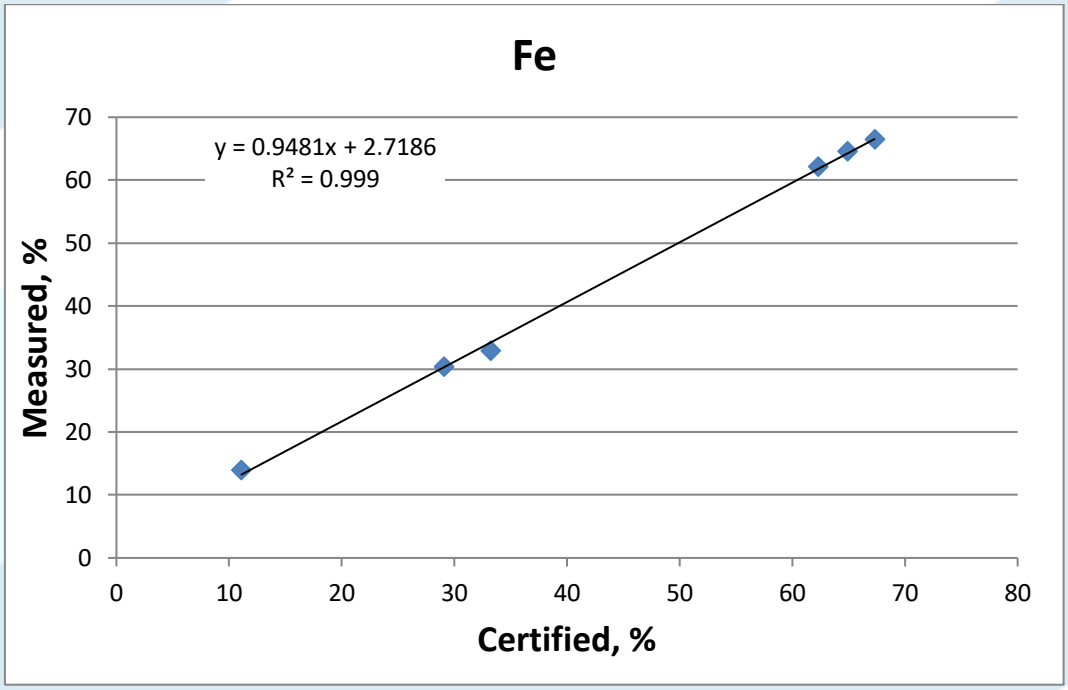

Figure 3. Correlation curve for Fe in iron ore.

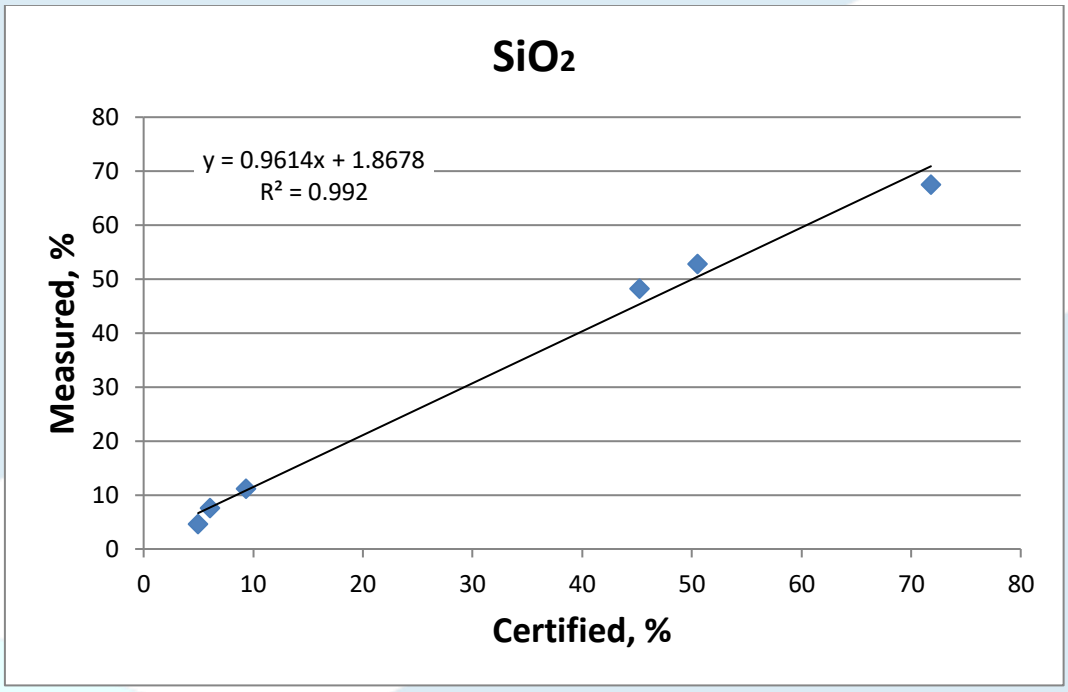

Figure 4. Correlation curve for SiO_2 in iron ore.

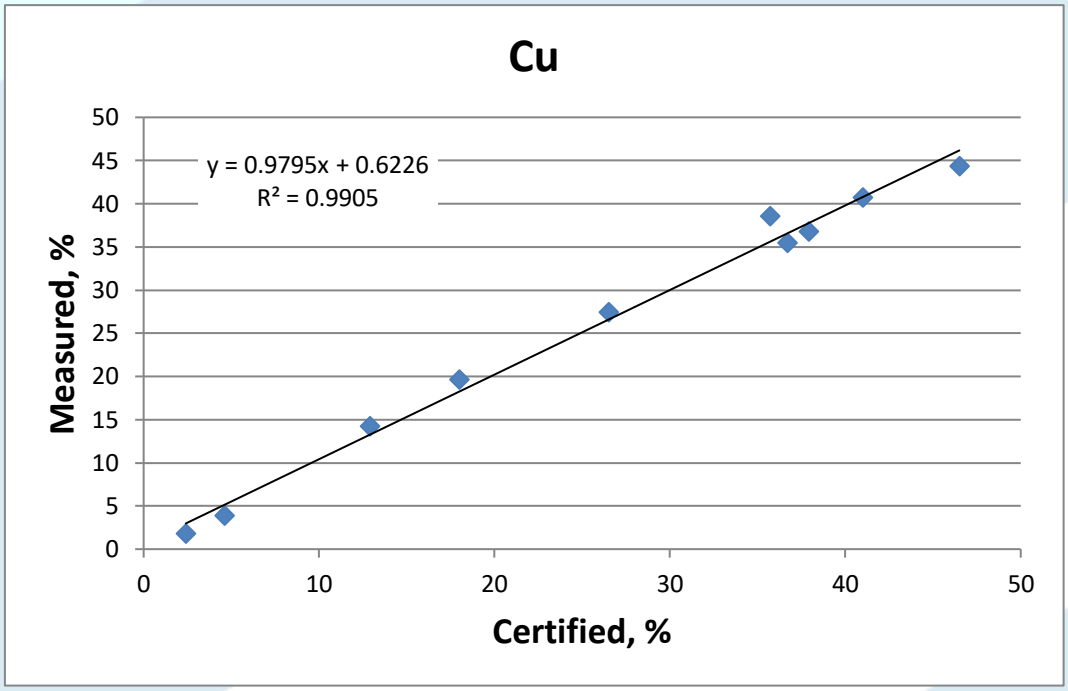

Figure 5. Correlation curve for Cu in copper ore.

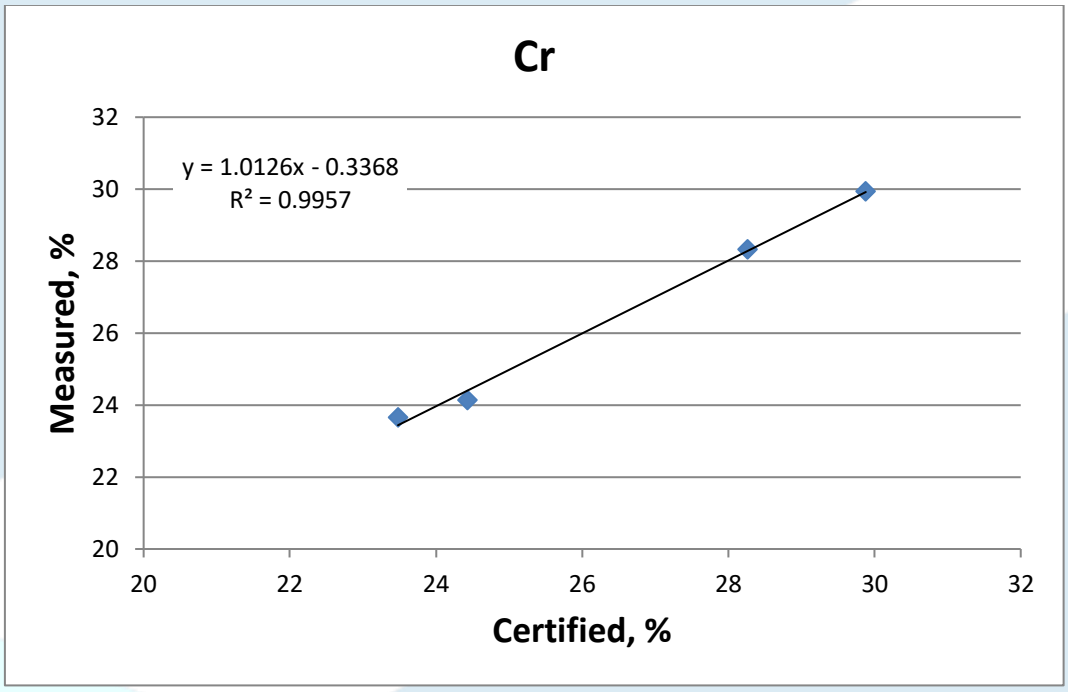

Figure 6. Correlation curve for Cr in chromite.

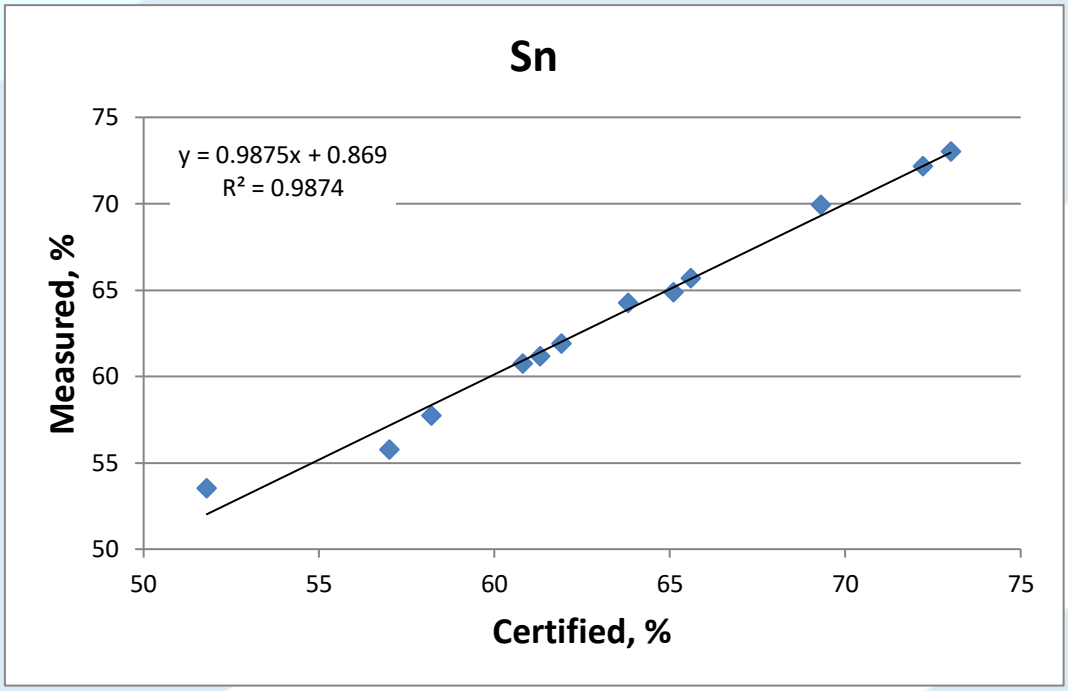

Figure 7. Correlation curve for Sn in tin concentrate.

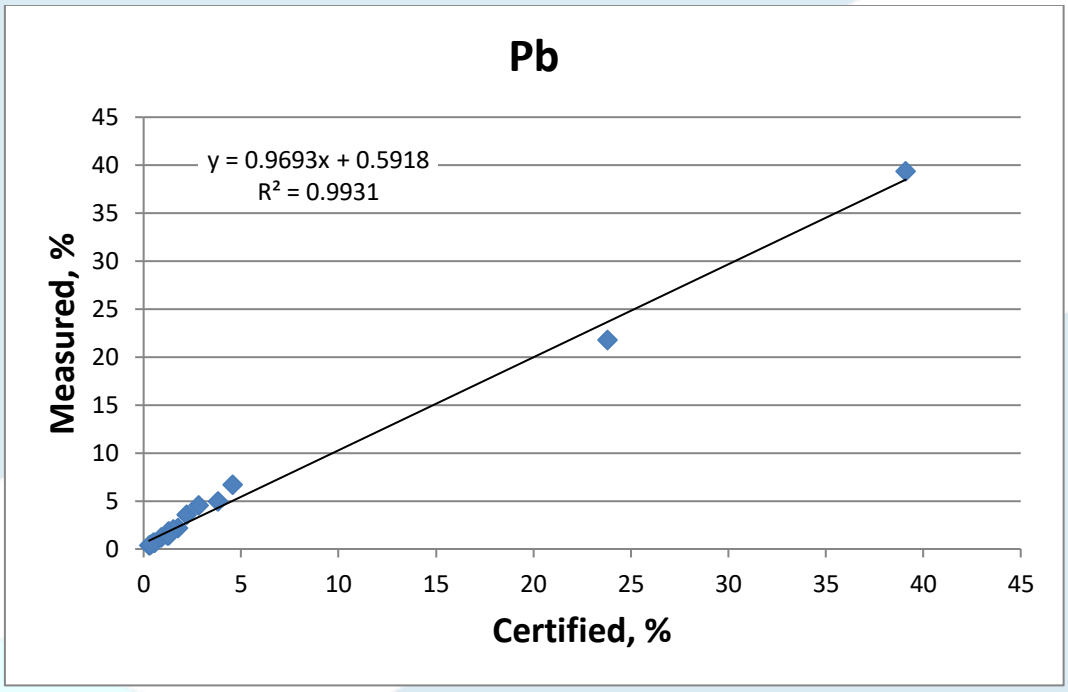

Figure 8. Correlation curve for Pb in polymetal ore.

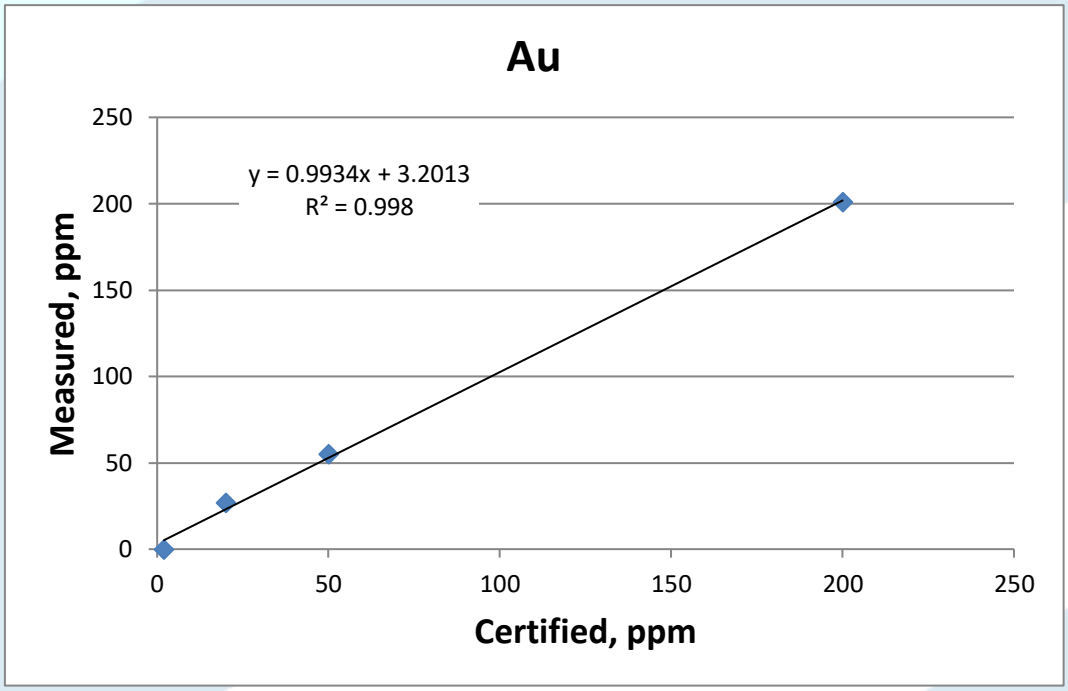

Figure 9. Correlation curve for Au in gold concentrate.

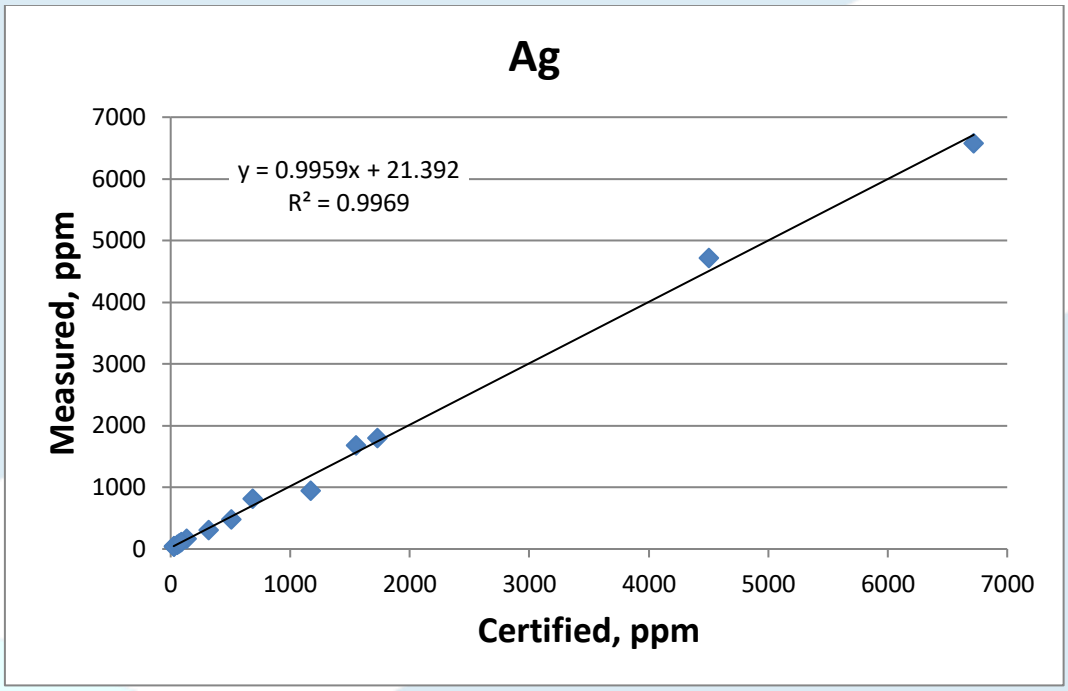

Figure 10. Correlation for Ag in silver ore.

Repeatability

Another important parameter of XRF device is measurement repeatability. The same sample of iron ore was measured 10 times for 60 seconds over a period of time. An average, standard deviation (Std Dev) and relative standard deviation (RSD) for Fe and SiO_2 content was calculated. Results are given in Table 1.

measure #	Fe, %	SiO_2, %
1	61.937	9.81
2	62.012	9.93
3	61.816	10.04
4	61.866	10.01
5	61.876	9.9
6	61.969	10.02
7	61.961	9.99
8	61.985	9.79
9	61.889	9.96
10	61.912	10.03
Average	61.92	9.94
Std Dev	0.05	0.06
% RSD	0.08	1.39

Table 1. Repeatability results for one iron ore sample.

Detection limits

Limits of detection (LOD) was obtained from blank SiO_2 sample measured by ElvaX ProSpector LE with FastSDD detector for 60 seconds each pass (2 passes).LOD was calculated as three sigma. LOD may vary depending from actual matrix, presence of interfering elements and measurement time.

Element	LOD, ppm
Mg	2300
Al	700
Si	base
P	500
S	300
Cl	900
K	150
Ca	60
Ti	20
V	12
Cr	7
Mn	5
Fe	10
Co	8
Ni	2
Cu	1
Zn	1
As	1
Se	1
Rb	1
Sr	1
Zr	2
Nb	2
Mo	1
Ta	3
W	2
Pd	5
Ag	6
Cd	7
Sn	16
Sb	40
Ba	50
La	40
Hf	2
Pt	2

Au	2
Pb	2
Bi	2
U	2
Th	2

Table 2. Detection limits (3 sigma) for ProSpector LE in SiO_2 matrix.

Conclusions

The results demonstrate the ability of ElvaX ProSpector instrument to analyze different ore types for elements of interest. Good correlation between lab and measured values was obtained. But it is necessary to make sample preparation before measuring to improve sample heterogeneity and obtain good result. Real time data from portable XRF device saves a lot of time and money in ore mining and production.