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## In-Field Measurements of Major Elements and Base Metals with Handheld LIBS

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Data for a handheld LIBS Device (SciAps Z-500) is presented demonstrating in-field measurement of several elements critical for geochemical applications. In some cases these elements have never before been measured with a handheld device.

A new handheld LIBS (laser induced breakdown spectroscopy) analyzer has been introduced for elemental analysis of geochemical samples. The SciAps Z-series handheld LIBS analyzers feature a pulsed, 5-6 mJ laser, 1064 nm Class 3 laser and high resolution spectrometer spanning the wavelength range 190 nm out to 860 nm (with optional coverage to 930 nm).

The Z also includes an integrated, replaceable argon purge. LIBS analysis in the presence of argon yields greatly improved precision and as much as 10x lower limits of detection compared to air-based laser analysis. The spectrometer's wavelength coverage offers analysis of virtually any element in the periodic table, including several elements that could never before be analyzed in the field with a handheld device: sodium, lithium, boron, beryllium, carbon, and fluorine.

### Major Element Geochemistry and Geochemical Indices:

For mineral and ore applications, the critical elements are Na, Ca, K, Al, and Si. Measurements of these elements yield widely used geochemical ratios including  $Ca/(Ca + Na)$ ,  $K/Na$ ,  $Al/(Ca+Na+K)$ , and  $Al/(Na+K)$ . In addition operators may analyze these indices versus  $SiO_2$  concentrations from the simultaneous Si measurement.

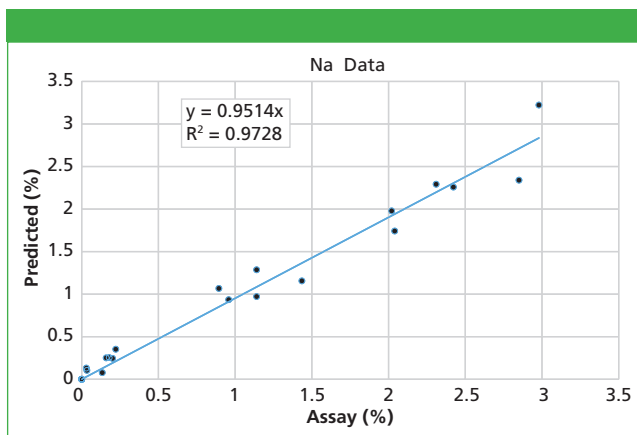


Figure 1: Sodium (Na) results for Z-500 versus assay.

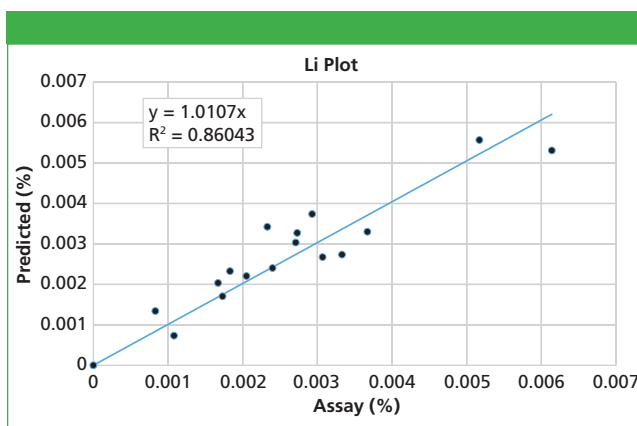


Figure 2: Lithium (Li) results for Z-500 versus assay.

Figure 1 shows results from Na analysis from igneous rock and iron ore mineral samples. Calibration models were built specifically for each ore type. The HHLIBS results compare favorably with the assay values. The rock material was pressed into a pellet approximately with a readily available field press. Calibration models were either polynomial curves fitted to CRMs or a multivariate PLS (partial least squares) model.

### Base Metal and Trace Elements:

The Z-500 also analyzes base metals and trace elements, including Mg, Ti, V, Cr, Fe, Mn, Cu, Ni, and others. Trace metals of commercial interest or as pathfinders including Li, Be, B, C, and halogens including F, Cl, and Br are also analyzed. Figure 2 shows results for Li analysis, as an example. The results for lithium analysis were reasonably good. While there is some scatter in the data, the HH LIBS is measuring very low concentrations, in the 10–30 ppm concentration range. In general, the results for B, Be, Mg, Ba and other elements were comparable in terms of correlation, with the Li data.

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