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An Investigation into the Efficacy of Elemental Distribution Mapping using Hand Held Laser-Induced Breakdown Spectroscopy for the Qualitative Characterisation of Geological Materials.

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Laser-Induced Breakdown Spectroscopy (LIBS) is an analytical technique that is capable of rapid and comprehensive elemental analysis of a wide range of sample types. Each element in the periodic table emits light in the 200-900nm spectral range allowing a complete chemical fingerprint to be captured simultaneously with a single laser pulse using a LIBS system capable of detecting a spectral response across this range. Significant developments particularly related to miniaturisation of laser and spectrometer components and associated optics and electronics have recently made it possible to conduct such analysis in the field or in-situ using hand held analysers. The availability of Hand Held LIBS (HHLIBS) is a recent development with several analytical instrumentation manufacturers beginning to offer commercially available analysers over the past 3 years. LIBS allows spatially precise sampling in the order of 10s of microns and a combination of these point analysis using X-Y rastering can be used to produce element maps.

In this study a mineralogically diverse selection of geological samples were analysed using a SciAps Z500 HHLIBS system with Extended Range Spectrometer (ERS) capable of collecting data over a spectral range of 675-850nm. This LIBS system uses an Argon purge to improve sensitivities in the Ultraviolet (UV) region of the spectrum and is capable of rastering across up to a $2mm^2$ area. Using the Z500 ERS it is possible to analyse many elements such as Li, Be, B, C and Na that have historically been difficult or impossible with hand held analytical systems in addition to many other useful elements for geochemical analysis. The LIBS analyser was used to generate qualitative element distribution maps that have then been compared to data acquired using other conventional techniques for the characterisation of geological materials. These techniques include hyperspectral analysis using the HyLogger-3 incorporating the anhydrous mineral spectrometer with a spectral range of 380-2500 nm and 6,000-14,500nm, qualitative and quantitative mineralogy using benchtop X-Ray Diffraction (XRD) analysis and elemental microanalysis using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA ICP-MS).

The in-situ analysis of mineral chemistry at the scales possible using HHLIBS offer many opportunities to geoscientists working in the field and with on-line, and in-process analysis of geological samples. The data generated by the above mentioned analytical techniques is intended to act as baseline to demonstrate the efficacy of using HHLIBS to produce element maps and to better understand the strengths and weaknesses of using this novel technique for the in-situ characterisation of geological materials. The integration of LIBS data with data from other conventional analytical techniques such as those listed above also has the potential to improve outcomes for characterisation of geological materials in these settings.