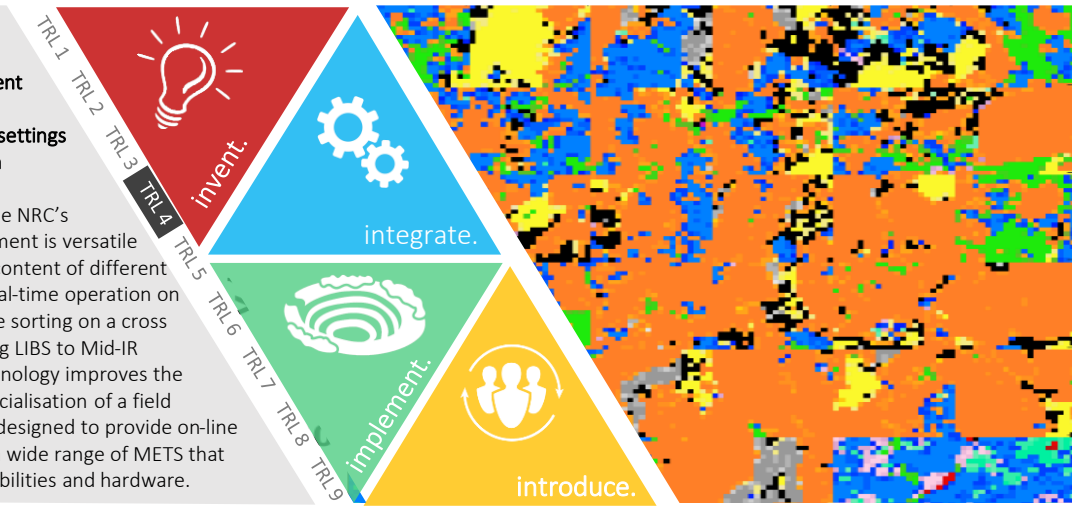
PROGRAM 2:
SEPARATE

LIBS analysis for geo-sensing

PROJECT P2-004

This project leads to major advancements towards an instrument capable of real-time identifying and quantifying minerals in a cross belt settings using the Laser-Induced Breakdown Spectroscopy (LIBS) technology.

Results and tests confirmed that the NRC's developed method for such instrument is versatile enough to determine the mineral content of different deposits, and robust enough for real-time operation on mine sites, for example for bulk ore sorting on a cross belt settings. Furthermore, coupling LIBS to Mid-IR quantum cascade lasers (QCL) technology improves the selectivity of the method. Commercialisation of a field deployable LIBS based instrument designed to provide on-line mineralogy is of direct interest to a wide range of METS that currently provide geo-sensing capabilities and hardware.



National Research Council Canada

CRC ORE

Research Collaboration

The National Research Council of Canada (NRC-CNRC) has extensive knowledge and expertise in LIBS technology. This includes successful implementation of LIBS in several commercial applications such as agriculture, mining, automotive, aerospace, security and pharmaceuticals. A dedicated multidisciplinary team with extensive background in optical physics, chemometrics, instrument prototyping, hardware components and software design with experience from previous and other on-going NRC's developments (soil, oil sands, gold ore, molten materials, slurries analysis) were brought to bear on new minerals applications with a focus on Grade Engineering® support through collaboration with CRC ORE.

The LIBS technology measures spectral lines associated with the elemental content of the materials ablated by the laser. Being composed of different elements or ratios of elements, each mineral is expected to generate a different spectrum or signature. For operation on mine sites, the laser probe beam cannot be made small enough to capture a single mineral but captures a mixture of them. A critical issue is then to delineate the signals to identify and quantify the minerals present in the spot. LIBS calibration and mineral signatures were first extracted from Cadia East deposit rock tiles, previously scanned by a Quantitative Mineral Analyser (QMA). A chemometric model was then developed to process the spectrum from mixed minerals, and to identify and quantify these minerals. Random probing of other tiles in point-counting mode were made to predict the mineral distribution.

The mineral abundance results were accurate at less than a few % for the major minerals. Work is underway to better quantify silicates that share too similar compositions. Mid-IR reflectance spectroscopy based on quantum cascade lasers have been coupled to LIBS to enhance the mineral discrimination method. Results clearly show the capability of the method to quantitatively predict the minerals in the tile.

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Timing:	April 2017 – December 2019
Participants:	NRC

Background

Converting elemental information to mineralogical assay has significant importance for geologists and mine planners in extraction operation. Indeed, providing quantitative values and distribution of the minerals helps in optimising the mining and milling processes, and to define the value of a deposit. Quantitative Mineral Analyser (QMA) such as the QEMSCAN® and the MLA® were developed to fill these requirements in laboratory setting. These instruments are based on dispersive x-ray spectrometry and scanning electron microscope (EDS-SEM). Real-time analysis of coarse rock streams would greatly enhance the decision-making processes and enhance the mining operation efficiency; however electron-microscope-based instruments are not yet adaptable for in-field measurements. As such, these instruments are bulky, delicate, time-consuming, and best suited for a laboratory environment. The current project seeks to develop a QMA that can be deployed on mine sites in a variety of settings from in-pit muck piles, underground draw points, cross-belt scanning, and on-line slurries.

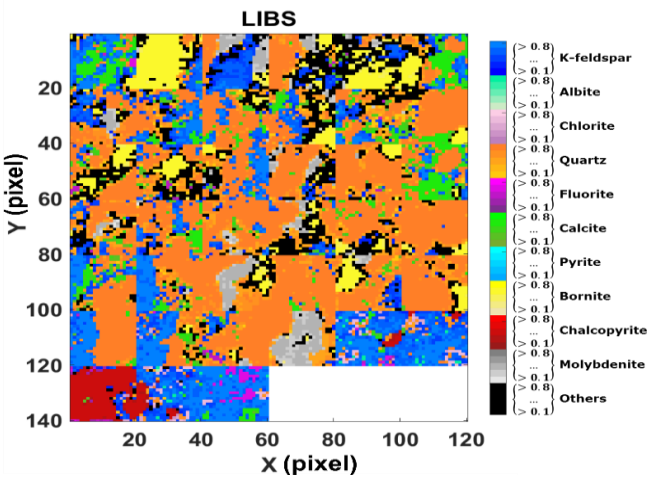

Image (top): QMA imaging of 10 mineral phases from Cadia East
Image (above): LIBS imaging of 10 mineral phases from Cadia East

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