Magnetic Resonance Bench Analysis
Stage 2b: TRL 5 Demonstration

PROJECT P1-019

The objective of this project is to test a mine bench sensing prototype at TRL 5 readiness. Measurement of a 50t ore sample has allowed testing to 2m depths. A project highlight is the successful measurement of high grade ore covered by a thick layer of low grade ore.

The ability to generate a high resolution, three-dimensional grade map of a bench is an enabling technology for assisting differential blasting and selective mining in the blast, dig and deliver phases.


Research collaboration

CSIRO has extensive experience developing Magnetic resonance (MR) based technology for mineral measurement, from concept through to commercialisation.

Through CRC ORE financial co-investment, a mine bench sensing system has been developed to TRL 5 demonstration. The system is the first of its kind, allowing the quantitative measurement of chalcopyrite at depth, which can be applied to mine benches prior to drilling, or for use in stockpile characterisation.
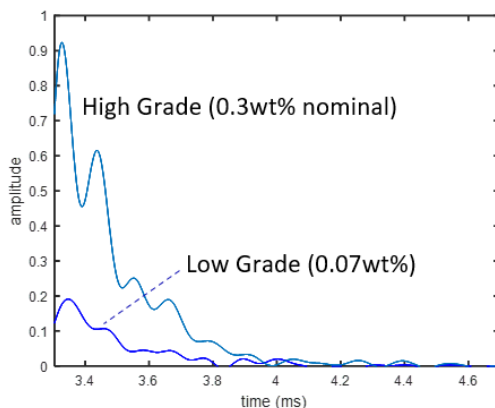
Magnetic resonance signals used for measurements of high and low grade ore.

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Project Leader:	Dr David Miljak, CSIRO
Timing:	April 2020 to April 2021
Next stage on from:	Project P1-015
Participants:	CSIRO

Background & aims

This project follows the successful completion of previous CRC Centre funded projects (CRC ORE projects P1-013 and P1-015) for development of a prototype mine bench sensing system. The concept involves an autonomous sensor platform *traversing the mine bench prior to drilling*, coupled with a new sensor approach capable of sensing mineral grade at depth, based on magnetic resonance (MR). MR is a radio frequency (RF) spectroscopy adapted by CSIRO for large volume bulk mineral sensing. Advanced mine bench characterisation of this type can lead to significant improvements for highly refined block model validation, blast optimisation, selective mining strategies and at-bench sensor-based ore sorting.

The prototype is suitable for traversal over a mine bench or stockpile. The analyser sensing component is integrated with a trailer unit for towing and can range over limited distances via tethering to a semi-portable electronics unit powered with a self-contained diesel generator set.

Testing has been completed on two 25t ore samples at CSIRO facilities to test sensing penetration through rock layers, at grades typical of stockpiles or mine cutoff. A key result is the demonstration of a high grade ore layer(0.3wt% cu-as-chalcopyrite) positioned under an intervening low grade porphyry rock layer, fulfilling the key aspect of TRL 5 demonstration. The measurements have been compared to detailed modelling analysis for the measured ore arrangements. The measurements and model show close agreement, providing further confidence in the sensor performance characterisation.

Focus on outcomes

- The MR bench sensing system developed is suitable for future testing on an open mine bench or stockpile, where deeper ore layers up to 3-4m an be presented to further validate the sensing technology.

- In future developments, a fully-autonomous solution can be used to routinely measure grade on a mine bench or stockpile (elevation of the technology to TRL 6-7).