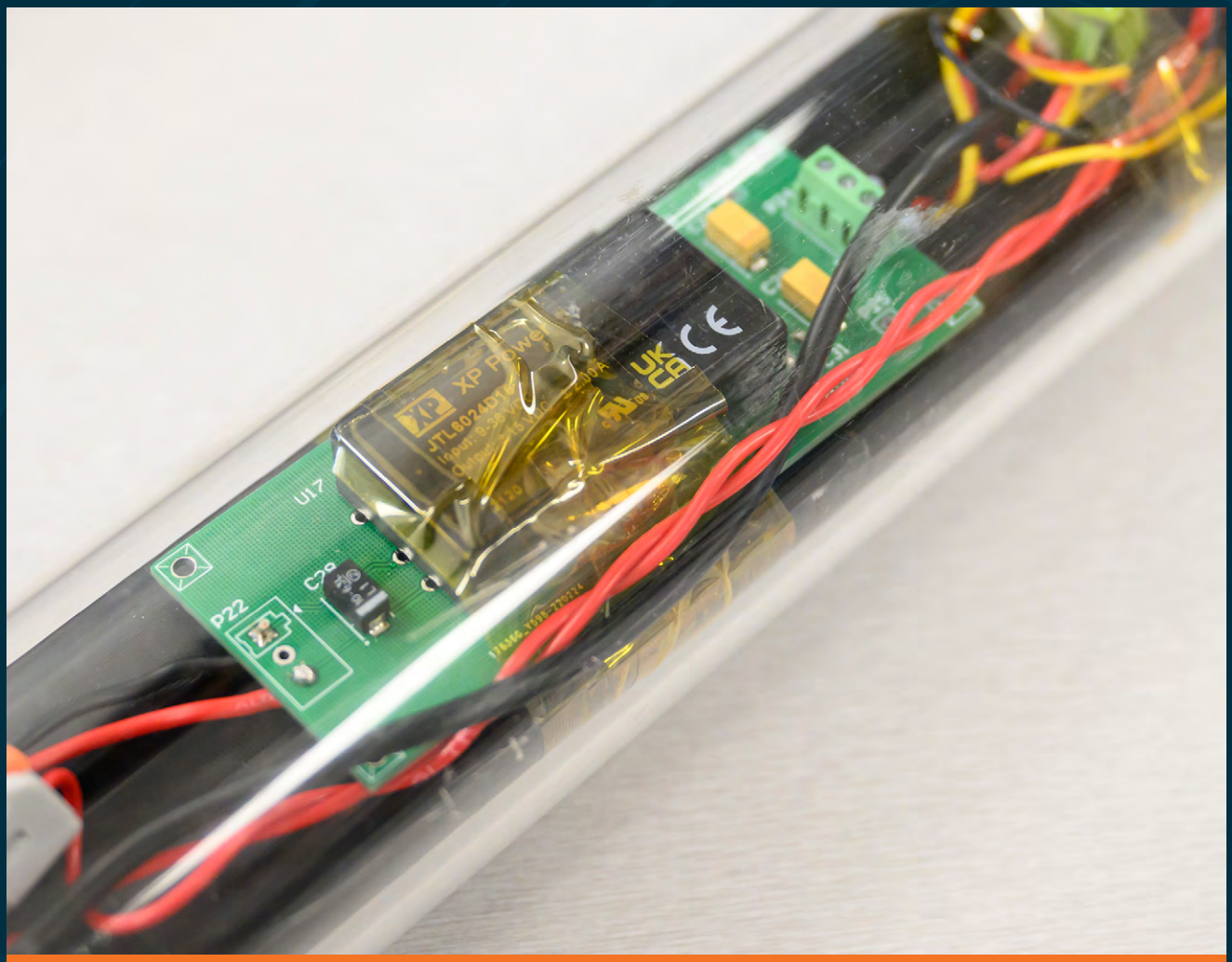
MinEx CRC

Australian Government
Department of Industry, Science and Resources

Cooperative Research Centres Program



DOWNHOLE SWEPT FREQUENCY EM TOOL

BRINGING NEW EXPLORATION TECHNOLOGY TO MARKET

RELIABLE, SENSITIVE DOWNHOLE EM FOR FREQUENCY DEPENDENT CONDUCTIVITY AND MAGNETIC SUSCEPTIBILITY

MinEx CRC are developing a downhole swept frequency electro-magnetic (EM) tool. The technology is documented in a confidential patent application. The tool incorporates an electromagnetic sensor system, that facilitates rapid cycling across frequency ranges between ~1000 to 100,000Hz, with multiple advantages over single or dual frequency tools. The prototype tool fits within NQ diameter boreholes and can be deployed by wireline or fitted to the drill string for logging-while-tripping or logging-while-drilling applications.

Exploration value of downhole EM

Borehole electro-magnetic (EM) tools have proven value in mineral exploration due to their potential to 'see' variations in electrical conductivity in the rocks surrounding a borehole. Rocks with high conductivity include many orebody types, particularly those containing a high proportion of sulphide minerals. These include critical minerals that underpin modern life.

The distance that EM tools can 'see' around the borehole (known as the radius of investigation, ROI) has a dependence on the transmitted frequency and the conductivity distribution in the formation. Conventional EM tools with single or dual frequency are limited to delivering averaged conductivity estimates of the material within relatively narrow ROIs. Tools of specific frequency need to be carefully chosen to match target characteristics and ground conditions.

In contrast, the MinEx CRC broad bandwidth swept frequency tool delivers rich EM information content, with enhanced ROI at each frequency sweep. The MinEx CRC system has numerous advantages over single or dual frequency tools.

Advantages of the swept frequency EM

Swept frequency EM has a number of advantages:

- Wide range of penetration depths (ROI)
- Broad application across different target characteristics and ground conditions
- Enhanced potential to detect off-hole features
- Signal-to-noise is readily optimised for targeted geo-electrical settings
- Rich, multidimensional EM data with potential to apply ML techniques

MinEx CRC Downhole Swept Frequency EM Tool

MinEx CRC are developing a first-of-a-kind downhole Swept Frequency EM Tool intended to deliver the benefits of broad bandwidth EM in a robust, driller operated tool suitable for deployment by traditional wireline or attached to the drill string.

Several prototype tools have been fabricated and successfully trialled in Curtin's deep research borehole, to a depth of 900m.

MinEx CRC Researcher, Hoang Nguyen (Curtin University).

MinEx CRC Communications Manager, Anna Porter.

Fit for purpose

The sensor system is small, light (less than 1kg), with independent power, independent data storage and a wireless communications system.

When assembled in its housing, the prototype tool has a length of ~1.7m and weight <5kgs making the prototype Swept Frequency tool lightweight, independent and easy to transport.

The assembled prototype has an outer diameter of 60mm. Significant further miniaturisation for future version of the tool is readily achievable.

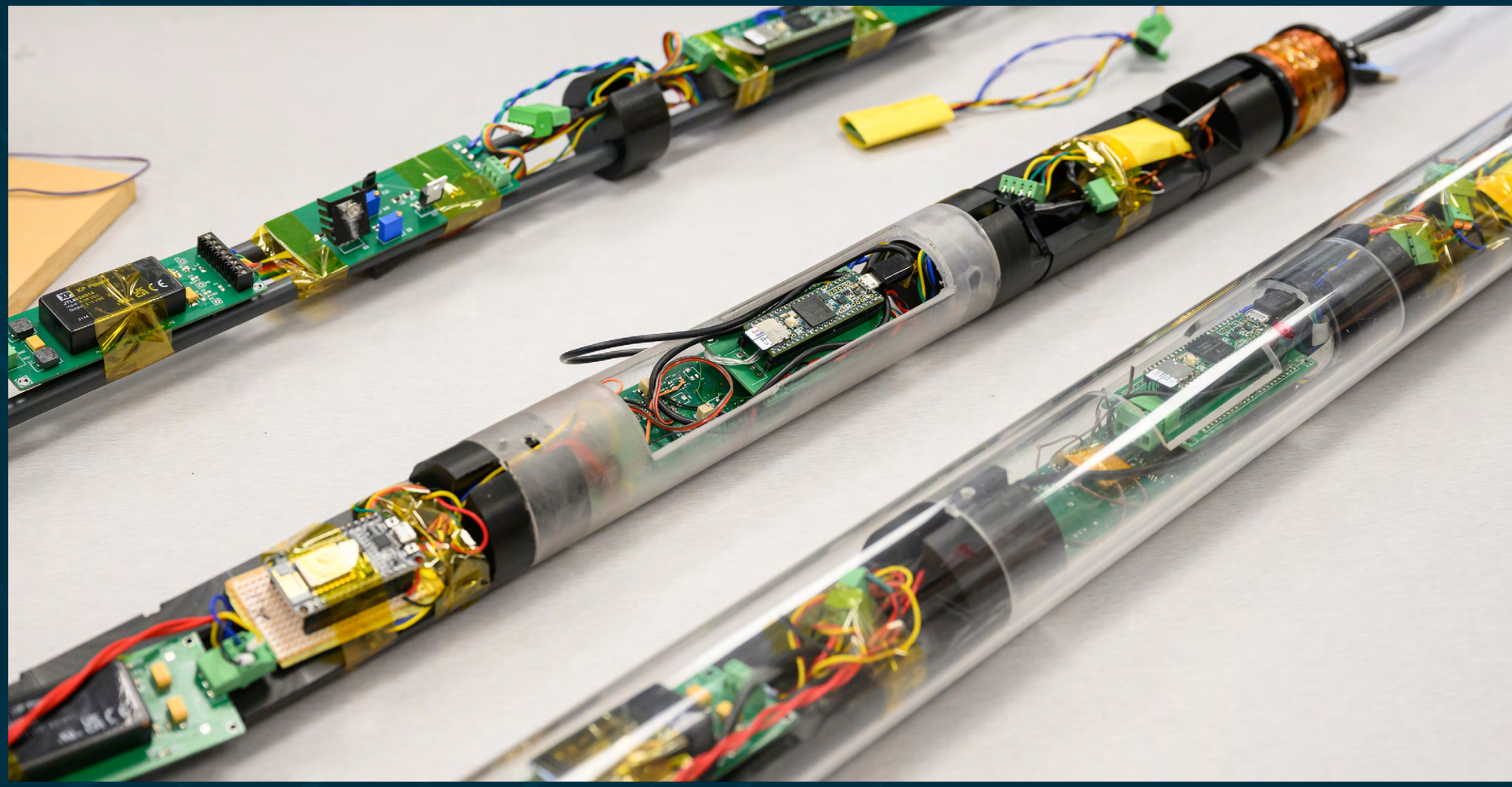
The tool will be driller deployable; either by wireline or by attachment to the drill string bottom hole assembly for logging-while-tripping applications.

Logging can be conducted in parallel with complimentary survey and geophysical logging techniques with little to no additional time penalty.

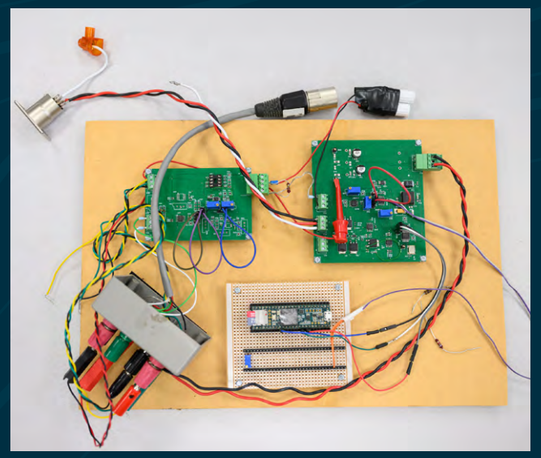
Reliable, quantified analyses

Test results and calibration of the MinEx CRC downhole swept frequency tool are underway. Several comparisons of the sensor response with conventional induction logging tool have been completed.

Ultimately standardised calibration procedures and processing methods will be provided to users to ensure accurate, precise analyse.



Prototype evolution of the downhole swept Frequency EM tool.



Rudimentary design stages of the downhole swept Frequency EM tool.

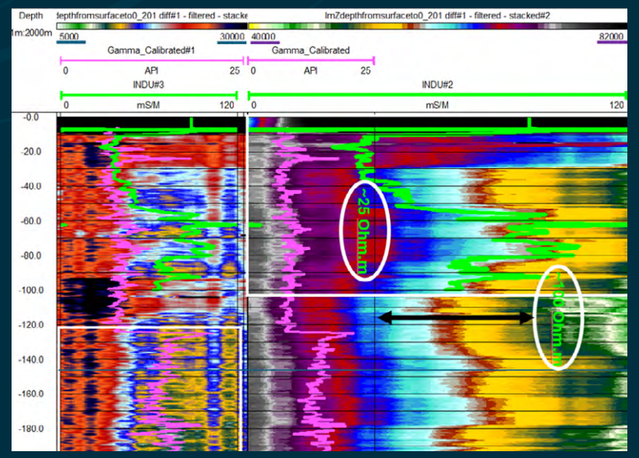


Image representations of uncalibrated data generated by the MinEx CRC swept frequency tool compared to single channel conventional gamma and induction wireline logs (the current swept frequency prototype swept frequency sensors generates 400 channels of data at each depth measurement).

TOOL OPERATIONAL SPECIFICATIONS

Physical	
Length	100 to 150cm (depending on tool configuration)
Diameter	60mm
Weight	4 to 6 kg (depending on tool configuration)
Pressure rating	10MPa (suitable for 1000m borehole)
Temperature rating	100ºC (suitable for all minerals drilling)

Technique	
Conveyance	Wireline or rig deployed on BHA (enables logging-while-tripping)
Data capture	Memory or uphole comms link depending on deployment method
Logging speed	Up to 10 m/min (logs 500m hole in 50 minutes)

* These numbers are based on our existing advanced prototype tools. However ultimate design of the sensor is flexible allowing it to be incorporated into a range of tools with physical specifications and deployment options optimised for the intended function.

PROJECT PARTICIPANTS

Project Industry Participants

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Minerals Research Institute of Western Australia

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Project Research Participants

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