Challenges in Designing a Magnetic Resonance Logging-While-Drilling Tool for Iron Ore Exploration

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ABSTRACT

Technological advances the sensor design and performance for logging while drilling (LWD) instrumentation offer considerable opportunities in iron ore exploration. Here we focus on the development of a nuclear magnetic resonance (NMR) LWD tool. NMR is an advanced geotechnical logging technology capable of providing *in-situ* measurements of the porosity, pore size and permeability of the formation of interest. The ability to provide real-time characterisation of iron-ore systems is beneficial to both drilling operations as well as real-time formation evaluation.

The development of a NMR LWD tool for mineral exploration drilling has previously not been achieved due to the significant technical and environmental challenges associated with the design and operation of such a tool. The tool outlined in this work is designed to work in reverse-circulation (RC) drilling systems. As such, the tool needs to be compatible with the RC drill-string, as well as being highly robust to survive the shocks and vibrations experienced during RC drilling operations. The magnetic physics of the probe must be capable of measuring at the appropriate depth into formation whilst being subject to the array of motions experienced during drilling operations. Furthermore, conducting accurate NMR measurements in an iron ore formations is challenging and the measurement methodology must be tailored to characterise the magnetic environment. The tool also requires high-powered electronics capable of operating the necessary pulse sequences for excitation and acquisition. The resultant tool design must therefore optimise the inherent trade-offs which exist between the physical components (i.e. mechanical structure, magnetic components and electronic hardware) in order to operate appropriately whilst not hindering RC drilling operations.

Current experimental analysis of the prototype is ensuring that the probe is demonstrating the required measurement specifications and is nearing field testing. Future work involves extending the measurement capabilities as well as looking towards commercialisation of the instrument.