ESTIMATING RESOURCE AND OPTIMISING PRODUCTION IN ISR AND BRINE MINING USING NUCLEAR MAGNETIC RESONANCE

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ABSTRACT

Understanding the Hydrogeological setting of ISR and Brine Deposits is vital to defining the available resource, as well as aiding in the optimisation and prediction of production results. Porosity, being the percentage of void space within a rock, can be used to determine resource volume (brine deposits) or understand water volumes and lixiviant concentrations for successful mining (traditional ISR). The permeability, or hydraulic conductivity, of the host rock will dictate the rate at which fluid can be extracted from the formation and consequently the rate at which the resource can be exploited. Additionally, porosity coupled with bulk density measurements can be used to calculate the dry bulk density of the host rock which directly impacts resource estimates in traditional ISR settings.

The well-established technology of Nuclear Magnetic Resonance (NMR) extensively used in other industries, has recently been made available for mining and groundwater applications, capable of resolving the complexity of hydrogeological systems at a higher resolution that alternative approaches. The Borehole Magnetic Resonance (WIREBmr™) tool is a downhole geophysical instrument that interacts with the fluid contained within the pore space directly and (i) measures the amount of fluid (total porosity), (ii) differentiates between moveable and non-moveable fractions (effective porosity) and (iii) infers how easily the fluid is likely to flow through the porous medium (permeability and hydraulic conductivity) as a continuous log. The downhole tool is environmentally friendly; there is no radiation emitted from the tool and offers considerable benefits over traditional downhole tools that estimate porosity. It works by generating magnetic fields and tipping hydrogen atoms using radio frequency pulses.

Potassium sulphate, or sulphate of potash (SOP), is mainly used in fertilisers and contains important nutrients for plant growth. It does not contain chloride which can be a detriment to plants that are chloride-sensitive such as avocados and coffee beans. Only 35% of SOP comes from natural resources and is considered a rarity. SOP is water soluble and can form mineable deposits below the subsurface hosted within hypersaline groundwater. SOP can be mined by extracting hypersaline groundwater via trenching or through boreholes and processing via evaporation ponds and s purification plant. Using data acquired from an Australian brine exploration project as a case study, we explore the advantages of using WIREBmr™ to determine aquifer properties as well as resolving the boundaries between aquifers and aquitards. This leads to better understanding of the available resource, improved decision making on production interval selection, and enhanced prediction of results during production. We further discuss how these measurements can be used across the ISR and Brine Mining spaces including the mining or copper, uranium, and lithium.

Keywords: Brine Mining, In-Situ Recovery, Sulphate of potash, borehole magnetic resonance, Porosity, Permeability