

REVIEW OF POTENTIAL FRACTURING METHODS (MICROWAVES, HIGH-VOLTAGE PULSES AND CRYOGENIC FLUIDS) FOR ACCESS CREATION IN LOW-PERMEABILITY HARD ROCKS FOR IN SITU METAL RECOVERY

By

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ABSTRACT

Rising mining costs and fewer high-grade ore deposits have necessitated a search for alternative methods for the recovery of metals from deposits that are no longer economically or environmentally exploitable by conventional mining. One such alternative method is in-situ recovery (ISR). Although ISR has typically been used for mining uranium ores that are not economic to mine with conventional methods, it has also been used less frequently for the treatment of other low permeability rocks, such as hard rocks containing copper, nickel and gold. The reason for the limited uptake of the technology for hard rock mineralisations is primarily due to the low natural rock porosity and permeability and hence limited ability of a lixiviant to permeate the rock and contact the minerals.

This review focuses on three potential access creation methods: microwaves, high-voltage pulses and cryogenic fracturing procedures. Microwave applications in mining and process metallurgy have been the subject of many research studies over the past two decades. Most have focused on energy savings in comminution, but little research has been done on the application of microwaves in ISR. Further, only preliminary investigations have been conducted to understand the factors that influence the change in permeability of rocks by high-voltage pulse breakage and cryogenic fracturing. The aim of this review is to summarize available information on these three methods for increasing the permeability of hard rocks and thereby improving the rate of lixiviant-mineral contact and mass transfer in in-situ recovery. The review will start with an overview of considerations for use of ISR. The mechanisms of microwave, high-voltage pulse and cryogenic fracturing methods will then be discussed.

Keywords: In situ recovery; Fracturing; Microwave; High-voltage pulse; Cryogenic fluid; Permeability.