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Evolution of porosity and permeability within fractured basalt formations for in-situ CO2 mineralization

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In-situ CO2 mineralization in basalt rocks shows significant potential to turn CO_2 into carbonate mineralization while fracture is the major flow path in basalt rocks. However, limited studies have been performed to unravel how the porosity and permeability evolute in fractured basalt rocks. To solve this problem, we designed a waterflooding system coupled with online Low Field Nuclear Magnetic Resonance (NMR) scanning under in-situ pressure conditions at 50^{o}C. The real time T2 curves were monitored for the whole sample while the Magnetic Resonance Imaging (MRI) for the fracture zone was reconstructed every 2 hours. In addition, the inlet flow rate remains constant while the pressure at the outlet is recorded constantly.

Our results show a unique porosity and permeability evolution pattern. The T2 curves reveal a periodic porosity evolution of fracture, where the porosity increases and decreases during the CO2 saturated water injection. The permeability follows a periodic evolution as well, where the permeability increases and decreases cyclically. We propose a pressure-dissolution-collapse mechanism to explain the observed periodic porosity and permeability. The fracture space increases with the rock dissolution while the fracture collapses once the strength of the rock cannot bear the overburden stress. Our findings provide insight into the fundamental evolution of petrophysical properties during in-situ CO2 mineralization.