Biologically Induced Mineralization for Subsurface Grouting

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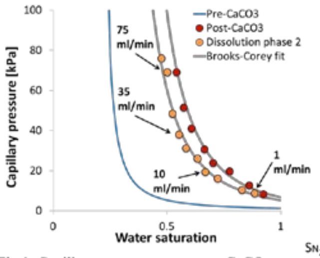
One method of biologically induced mineralization utilises soil bacteria *Sporosarcina pasteurii* to precipitate calcium carbonate. Injection strategies can be manipulated to allow controlled precipitation of the $CaCO_3$ making it a promising low viscosity grouting technique. We present two engineering applications for grouting with biologically induced mineralization: sealing fractures in the host rock of a radioactive waste geological disposal facility, and reducing leakage from a carbon capture and storage reservoir.

Using a large scale artificial fracture consisting of a granite lower fracture surface and transparent polycarbonate upper surface, the extent of calcium carbonate precipitation and fracture hydraulic aperture reduction was monitored. It was found that a three order of magnitude reduction in hydraulic aperture could be achieved with only five injection cycles. Precipitated $CaCO_3$ was both uniform across the 3 m^2 surface area and strongly attached to the fracture surface.



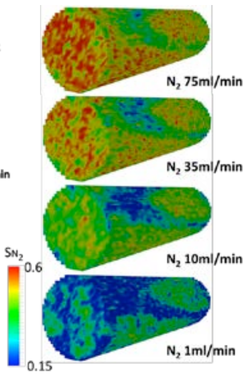


Fig.1. Capillary pressure curves pre-$CaCO_3$ precipitation, post-$CaCO_3$ and post-dissolution. Measured N_2 saturation distributions at selected N_2 flow rates during the dissolution capillary pressure measurement shown on the right.

To assess the longevity of a biologically precipitated seal under the acidic conditions arising in a carbon capture and storage reservoir, multiphase flow through a Berea sandstone core was characterised before $CaCO_3$ precipitation, after precipitation, and after accelerated dissolution. X-ray CT scans allowed spatial measurment of porosity, saturation, capillary pressure and permeability throughout the core (Fig. 1.). CaCO3 precipitation reduced permeability from 890 mD to 40 mD. Dissolution did not form preferential flow paths and resulted in only a small increase in permeability.