**INTRODUCTION**

Ureolytic-driven microbially induced calcium carbonate precipitation (MICP) has been investigated for sealing high permeability regions, like fractures, in the subsurface. Among other applications, this technology has the potential to improve the long-term security of geologically-stored carbon dioxide (CO2) by sealing fractures in cap-rock or mitigate leakage pathways to prevent contamination of overlying aquifers from hydraulic fracturing fluids (Fig. 1).

**METHODS**

**INJECTION STRATEGY DEVELOPMENT**

**HIGH PRESSURE VESSEL (HPV) DESIGN**

To study MICP under relevant subsurface conditions, a high pressure vessel was designed and constructed (Fig. 4 & 5).

**HIGH PRESSURE CORE FRACTURE SEALING**

**RESULTS CONT.**

**RESULTS**

**LOW PRESSURE CORE SEALING**

Figure 2. A decay-var model was developed to more quickly analyze injection strategy methods hypothesized to control precipitation.

**HIGH PRESSURE CORE SEALING**

Figure 3. A core of the Boyle Sandstone member of the Potolsville Formation in Alabama known as a site of outcrop from a CO2 storage (related fracture) was drilled and cored with a center 2" bore.

**HIGH PRESSURE CORE FRACTURE SEALING**

Figure 4. HPV houses sample up to 76 cm (30") dia. and 66 cm (26") height (Fig. 5) designed to contain samples up to pressures of 96 bar (1400 lb/in²) and with a temperature control system to observe and the ability to 90° rotation of the system is equipped with a data-logger equipment which monitors differential pressure, flow rate, pH, and conductivity.

Then, the fractured core was seeded under subsurface relevant pressures relating to 407 meters (1300 feet) or 48 bar. After fracture sealing, the sandstone core was , seeded three times with high bar pressure than during the initial fracturing event (Fig. 7). These studies suggested microbially induced calcium carbonate precipitation technologies may potentially seal and strengthen high permeability regions or fractures in the subsurface.

**CONCLUSIONS**

Ureolytic-driven MICP can be controlled by manipulating 1) ureolytic activity 2) transport and reaction rates of substrate and 3) calcium carbonate saturation conditions to:

- Promote homogeneous distribution of calcium carbonate along a flow path
- Prevent near-injection point plugging, and
- Seal fractures under ambient and relevant subsurface conditions

**FUTURE WORK**

**HIGH PRESSURE AXIAL FLOW**

A header-type core holder system has been used to perform three axial flow ureolytically-driven MICP experiments at 75 bar using similar injection strategies as previously described. Initial results suggest:

- biofilm formation as well as the flow rates during the calcium growth media
- injection (Kc) impacts the required calcium pulses to reduce permeability
- mineralization more greatly impacts (reduces pore space) in pores ranging from 5-15 microns, suggesting small aperture fractures are the target for MICP sealing.

Additional research is also being conducted to determine the impact of scCO2 on mineral, pore size distribution, and minimum capillary displacement pressure. Thin section analysis is being performed to examine biologic impact to mineral formation.

**RELATED PUBLICATIONS**


**ACKNOWLEDGEMENTS**

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**REFERENCES**


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