Coupled mechanism of capillarity and carbonation in the oilwell cement during $ScCO_2$ invasion

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Abstract

Supercritical CO_2 ($ScCO_2$) invades oilwell cement under geological CO_2 sequestration conditions. With the penetration of $ScCO_2$, cement structure prone to damage when the coupled effects of capillarity and carbonation were found. Microstructural evolution of oilwell cement samples was investigated by the CT scanning and the quantitative image-based analysis and show that $ScCO_2$ with the high humid condition would penetrate much deeper than the dry $ScCO_2$ because of the capillarity effects. Due to the deep saline condition in the sequestration formation, the penetration of $ScCO_2$ was retarded by the salt deposition, comparing with the ultrapure water (UP water) conditions. For further assessment of this coupled mechanism, the permeability property and contact angle changes were proposed to analyse the interface region between $ScCO_2$, saline/UP water and oilwell cement.

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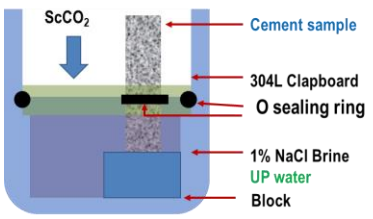
Salt deposition and severe corrosion

Designed kettle:

1) Isolating the $ScCO_2$ dissolving into the water below clapboard.
2) Isolating the water or brine vaporing into the $ScCO_2$.
3) This kettle will provide a pressure imbalance condition when simulating the sealing conditions.

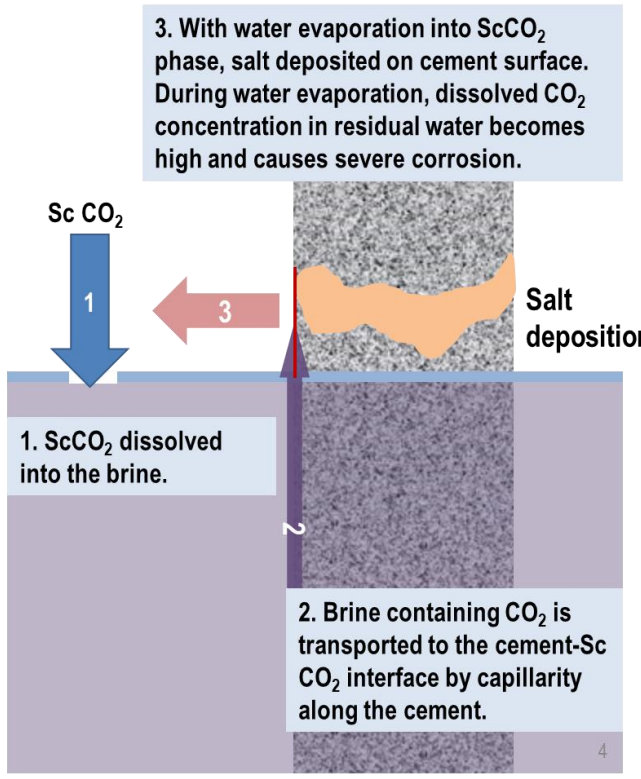


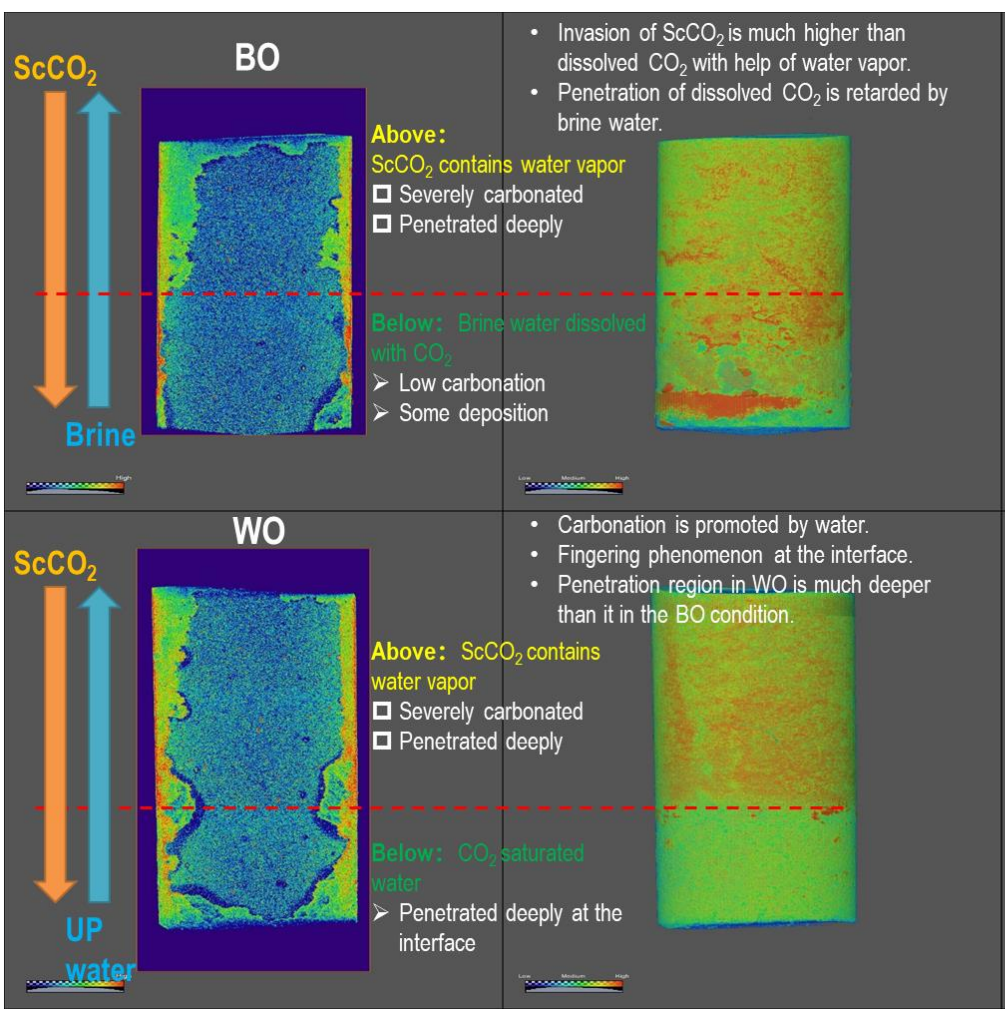
Experiment parameters:

Sample: G class oilwell cement with w/c=0.44;
Temperature: 62 ℃;
Pressure: 17 MPa CO_2;
Time: 14 days;

Four comparing groups:

BO -- Brine dissolved with $ScCO_2$
BS -- Brine isolated from $ScCO_2$
WO -- UP water dissolved with $ScCO_2$
WS -- UP water isolated from $ScCO_2$





- Deposition on the surface should be carbonates, salts or mixture of two in the different conditions.
- The interface region between $ScCO_2$ and brine/ UP water should involve the contact angle and the wetting properties of two phases.
- At the imbalance condition, how to figure out the capillarity effects of cement stone.