COLLEGE OF ENGINEERING

Chemical, Biological, and Environmental Engineering

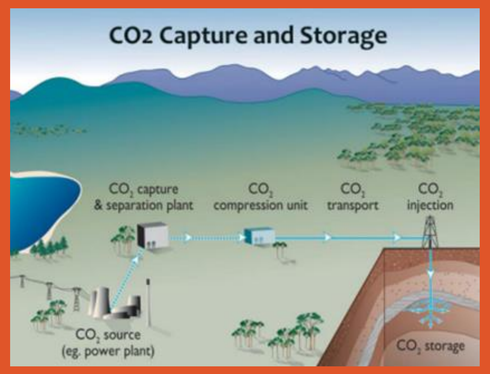
REDUCING CONNECTIVITY OF INJECTION FLUID IN POROUS MEDIA

WITH APPLICATIONS TO GEOLOGICAL CARBON SEQUESTRATION

Reduced connectivity of the nonwetting phase increases residual saturation, which when applied to geological carbon sequestration could result in larger volumes of carbon sequestered. This project intends on determining which factors have the greatest influence on the interconnectedness of the nonwetting phase.

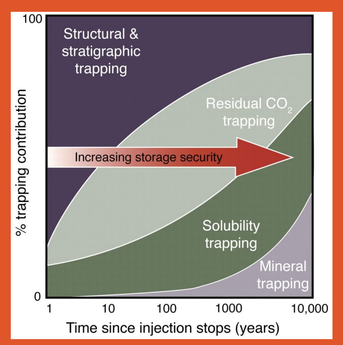
MOTIVATION

After the carbon concentration in the atmosphere surpassed over 400 ppm in 2013, The IPCC stated in their Fifth Annual Assessment Report that Carbon Capture and Storage (CCS) is necessary to keep the cost low when reaching climate goals. Increasing the amount of CO_2 trapped in the subsurface during geological sequestration would improve efficiency, thereby reducing the carbon in the atmosphere and decreasing the costs needed to do so.

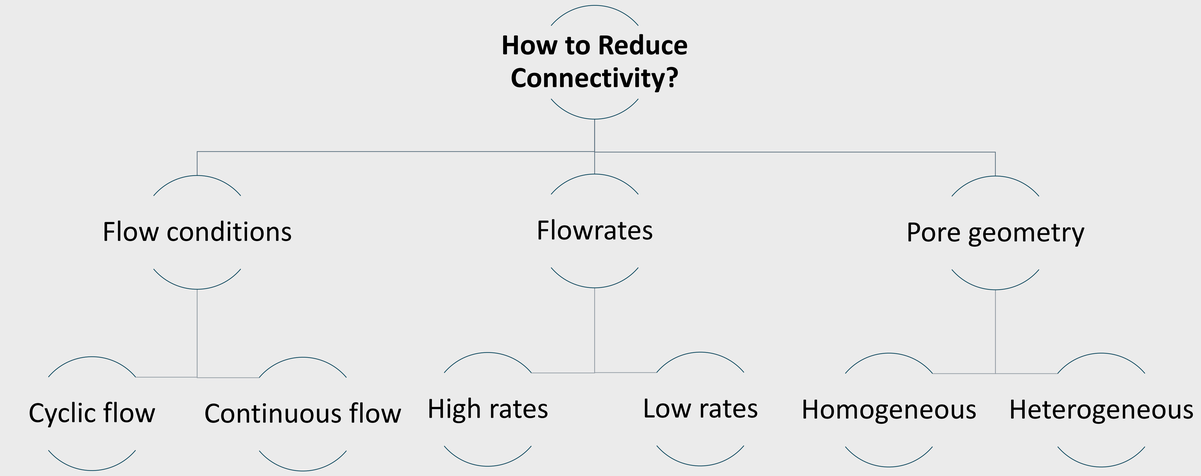


BACKGROUND

Imbibition and drainage are hysteretic processes that describe a fluid's movement through porous media. The wetting phase, the phase with a contact angle on the solid of <90º, saturates the media in primary imbibition. When CO_2 is injected, the nonwetting (NW) phase, the phase with a contact angle of >90º, floods the media and displaces the wetting phase during primary drainage. Secondary imbibition occurs during the displacement of wetting phase as it replaces the NW phase, similar to when brine reenters the media and displaces the CO_2. The amount of NW phase remaining is deemed the residual saturation.



Oregon State University



PROJECT GOALS

1. Determine the flowrate type that results in higher residual saturations of the NW phase.
2. Replicate results that indicating cyclic flow's effect of reducing connectivity.
3. Observe relationship between heterogeneity and corresponding residual saturation,.
4. Replicate findings with larger scales to ascertain these results are applicable in the field.

MICROTOMOGRAPHY TECHNIQUES

Prior to saturation, the dry sample will be scanned in the microCT scanner at Oregon State University. Following primary and secondary imbibition, the sample is scanned again to attain information on the residual nonwetting phase saturation, which will indicate which parameters reduce connectivity. This microCT has a helical scanning trajectory, allowing the sample to rotate in front of the x-ray beams providing a full spectrum visual in one scan.

TEST MATRIX

These tests will be performed using a microCT scanner and processed using Avizo software. Permutations of the following variables will be used for experimental testing:

Flow conditions: Cyclic or continuous flow

Flowrates: 0.01, 0.1, or 1 (mL/hr)

Media: Glass beads or sandstone

Sample Diameter: 0.7 or 2.5 cm

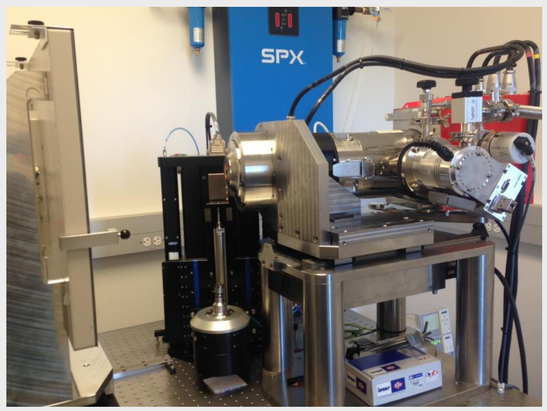
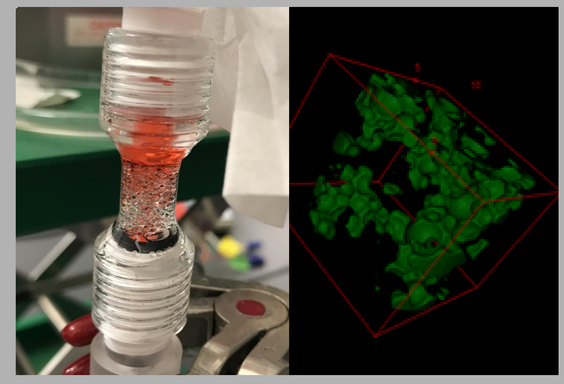


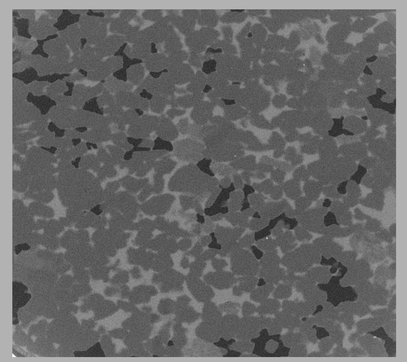
IMAGE PROCESSING

Avizo image processing software will be used to measure the surface area, interfacial area, contact angles, pore lengths, and residual saturations as well as connectivity and pore distribution. The dry scan and post scan are aligned and further segmented into 3 phases (media, wetting phase, and NW phase) to extrapolate data on the fluids' connectivity.



EXPECTED RESULTS

1. Lower flowrates will result in higher residual saturation of the NW phase.
2. Cyclic flow conditions will prove to be more beneficial than continuous flow conditions.
3. Increased heterogeneity will result in decreased connectivity.
4. Increased scales will result in similar findings as the smaller initial scale.



RESEARCH TEAM

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