Geologic CO₂ Storage: Insights from Pore-Scale Experiments

Anna Herring
Dept. Applied Maths, RSPE
Carbon Capture and Storage (CCS)

Negative emissions physically needed to keep global warming below 2 °C

T. Gasser, C. Guivarch, K. Tachiiri, C.D. Jones & P. Ciais

To limit global warming to < 2 °C we must reduce the net amount of CO₂ we release into the atmosphere, either by producing less CO₂ (conventional mitigation) or by capturing more CO₂ (negative emissions). Here, using state-of-the-art carbon-climate models, we quantify the trade-off between these two options in RCP2.6: an Intergovernmental Panel on Climate Change scenario likely to limit global warming below 2 °C. In our best-case illustrative assumption of conventional mitigation, negative emissions of 0.5–3 Gt C (gigatonnes of carbon) per year and storage capacity of 50–250 Gt C are required. In our worst case, those requirements are 7–11 Gt C per year and 1,000–1,600 Gt C, respectively. Because these figures have not been shown to be feasible, we conclude that development of negative emission technologies should be accelerated, but also that conventional mitigation must remain a substantial part of any climate policy aiming at the 2 °C target.
Geologic Storage

CO₂ Injection

>1,000 m

Impermeable caprock

Buoyant CO₂ migration
Geologic Storage

CO₂ Injection

>1,000 m

Buoyant CO₂

CO₂ Brine
Rock Grains

4 mm
X-ray CT via the ANU CT Lab

Core Sample

Detector

X-ray Source
X-ray CT Data

- Highly spatially resolved (2-6 µm voxel size)
- Quantitative
- 3D
Pore-scale Fluid Connectivity

Isosurfaces of fluid ganglia at 9% saturation (each individual ganglia is color-labeled)

- 3D Fluid connectivity and distribution can be quantified using geometry, topology, persistent homology
- Fluid connectivity is linked to fluid stability – more interconnected fluid ganglia is more mobile (less secure)

20 µl/hr 3000 µl/hr
Collaborators
Rex Li, Vanessa Robins, Moh Saadatfar, Mark Knackstedt, Adrian Sheppard, Ben Young, Fleur Gilby, Ines Butz, James McClure, Mick Turner, Levi Beeching, Andrew Kingston, Jill Middleton (+ everyone in the AM tea room!)

Funding
CO$_2$CRC
ANLEC R&D
ANU/UNSW Digicore Research Consortium
ARC DECRA DE180100082