

Comparison of CO₂-Brine and N₂-Brine Relative Permeabilities on Multiple Rock Types

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Introduction

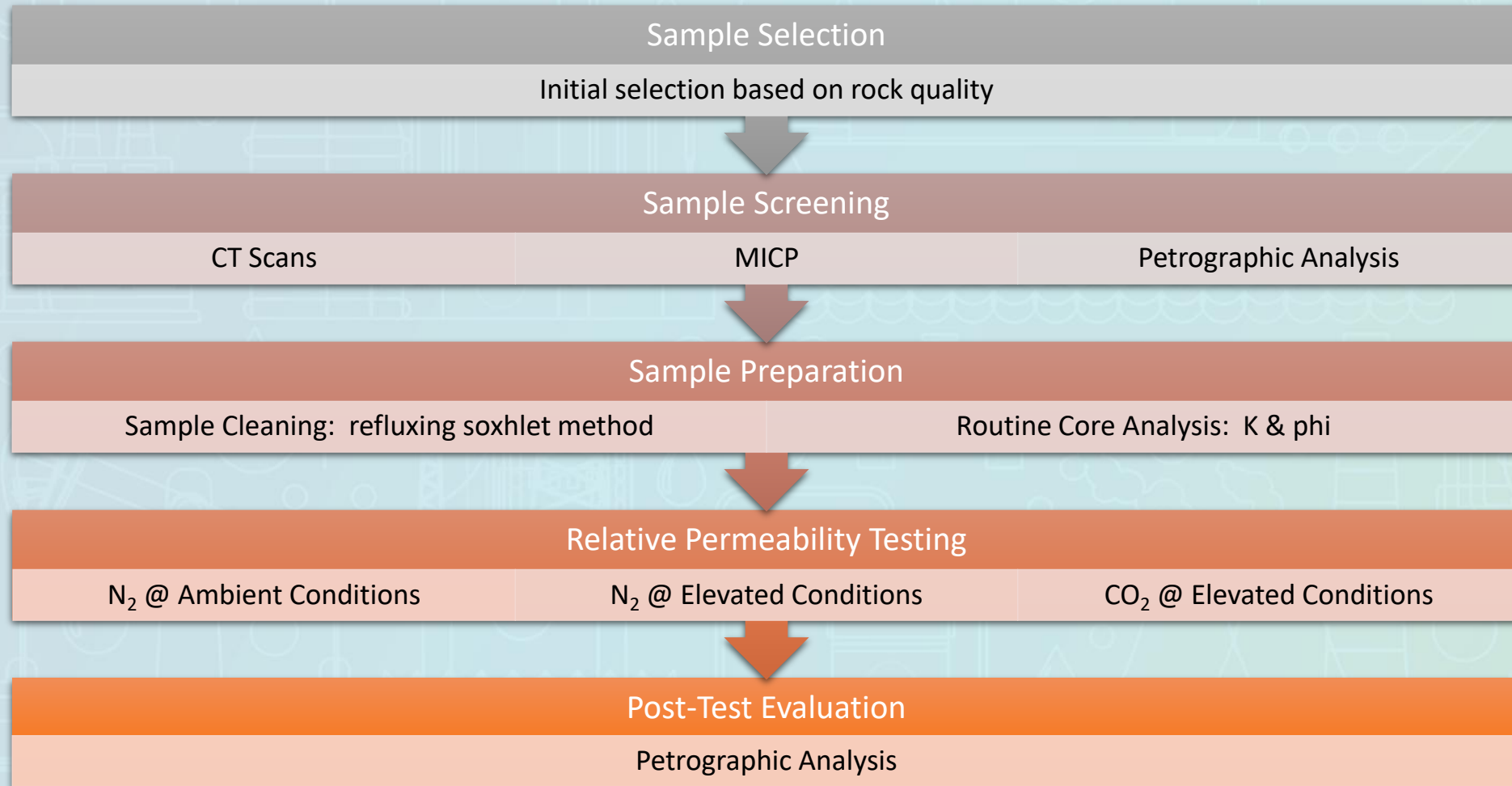
- **Why?**
 - **Use Case(s) as Highlighted by the Industrial Client**
 - **Constraints**
 - **Cost**
 - **Timing**
- **Challenges**
- **General Workflow**
- **Results**
- **Ongoing Analysis & Future Work**

Why?

Clients asked.

- **Challenges**
 - Test system interaction
 - Testing concerns
- **Increased cost**
- **Increased timing**

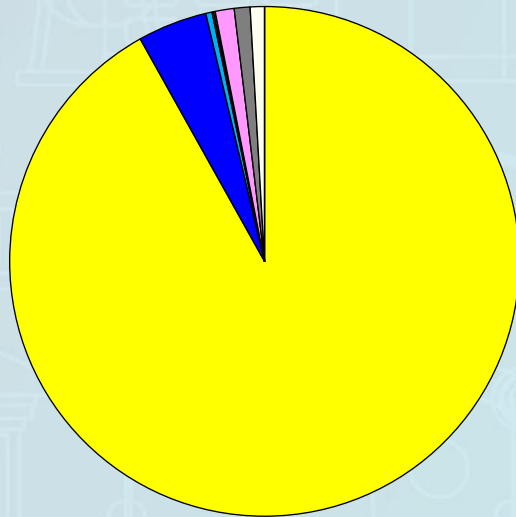
General Workflow



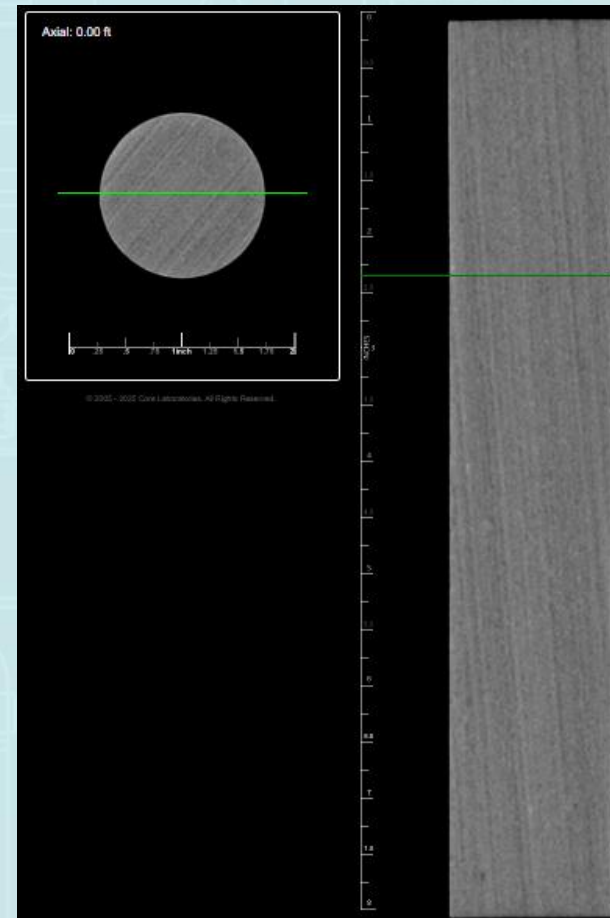
Sample Selection

Nugget

K_{air} , md = 157, Φ , % = 12.5, ρ_g , g/cm³ = 2.639



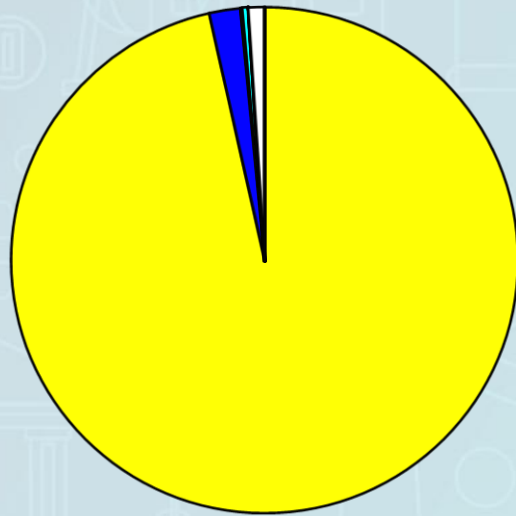
- Quartz
- K-Feldspar
- Plagioclase
- Calcite
- Dol. & Fe-Dolomite
- Pyrite
- Analcime
- Illite/Smectite
- Illite & Mica
- Kaolinite



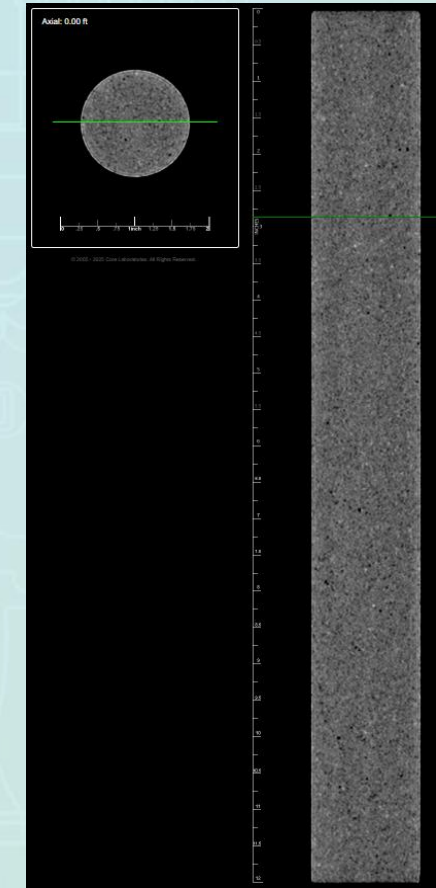
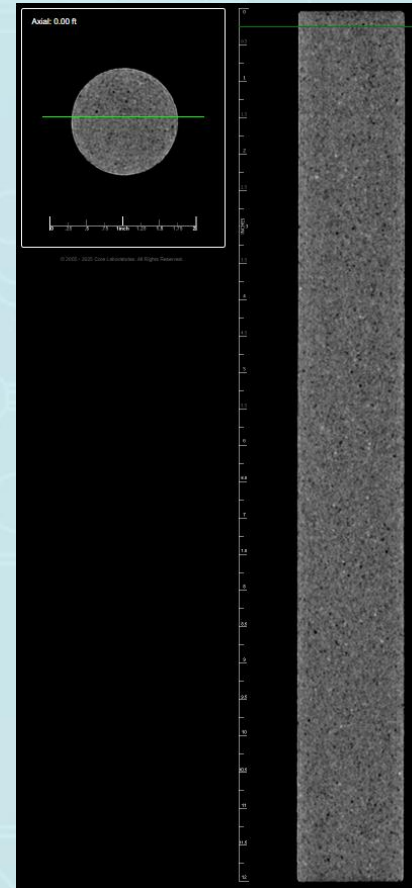
Sample Selection

Bentheimer

K_{air} , md = 2670, Φ , % = 22.5, ρ_g , g/cm³ = 2.635

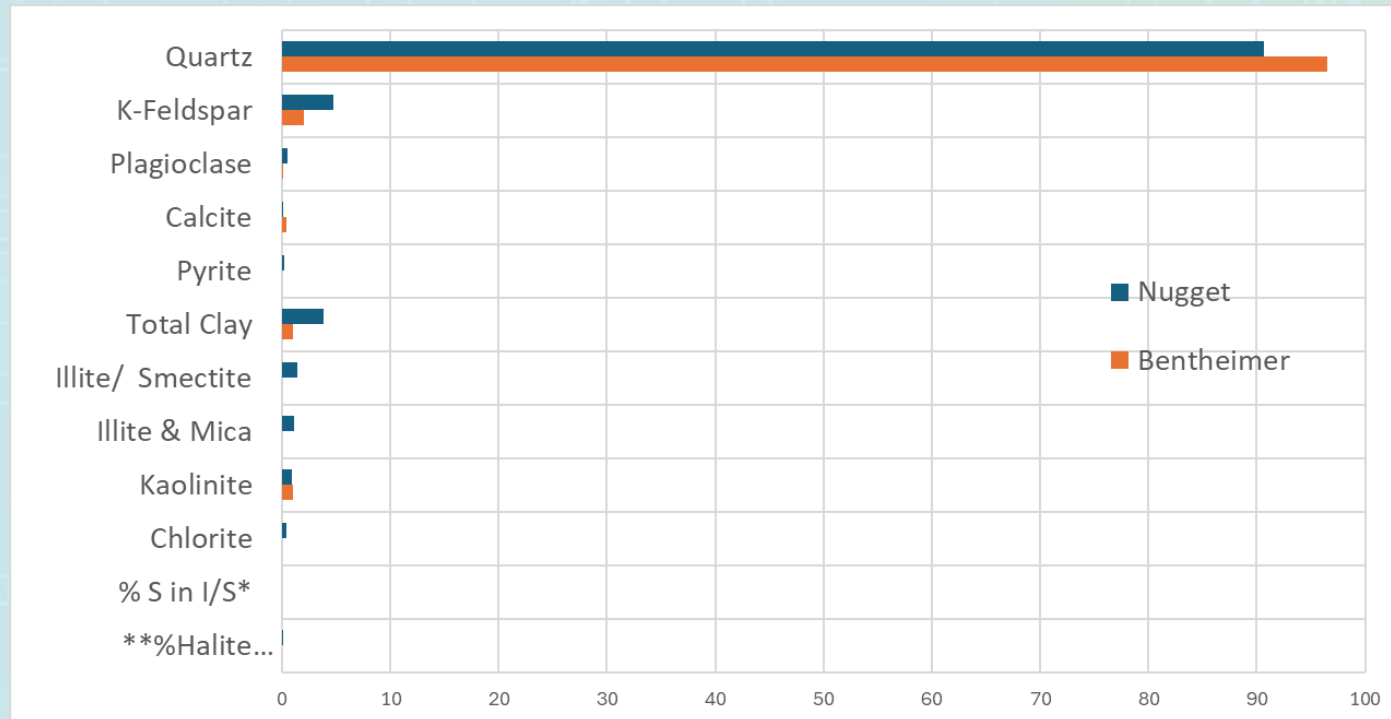


- Quartz
- K-Feldspar
- Plagioclase
- Calcite
- Dolomite
- Pyrite
- Analcime
- Clinoptilolite
- Illite/Smectite
- Illite & Mica
- Kaolinite
- Chlorite



Sample Selection

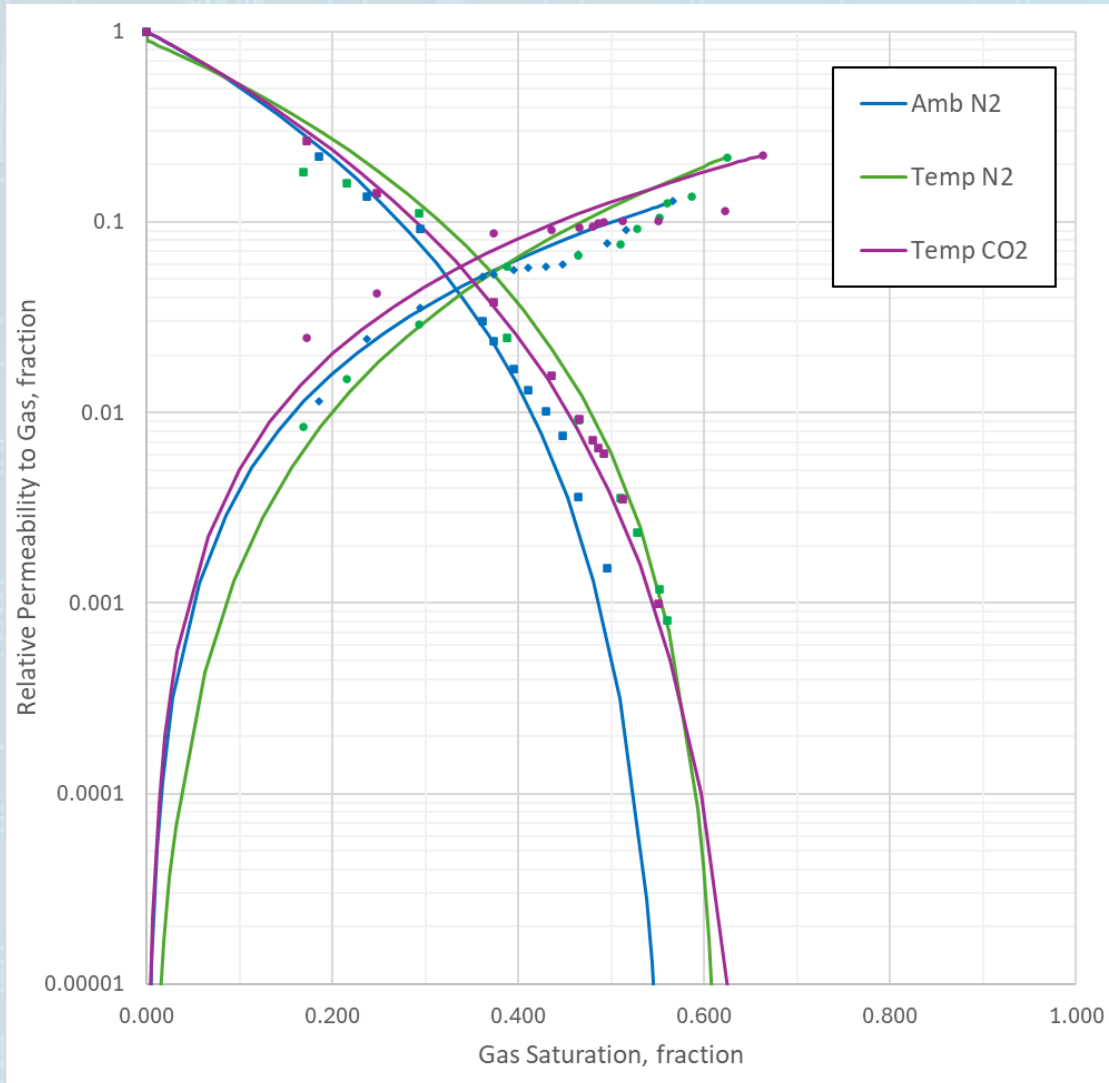
	Sample	Nugget	Bentheimer
Whole Rock Mineralogy (Weight %)	Quartz	90.7	96.5
	K-Feldspar	4.7	2.0
	Plagioclase	0.5	0.1
	Calcite	0.1	0.4
	Pyrite	0.2	0.0
	Total Clay	3.8	1.0
	Clay (Phyllosilicate) Mineralogy (Weight %)	Illite/ Smectite	1.4
Illite & Mica		1.1	0.0
Kaolinite		0.9	1.0
Chlorite		0.4	0.0
% S in I/S*		10-20	-
**%Halite		0.1	0.0



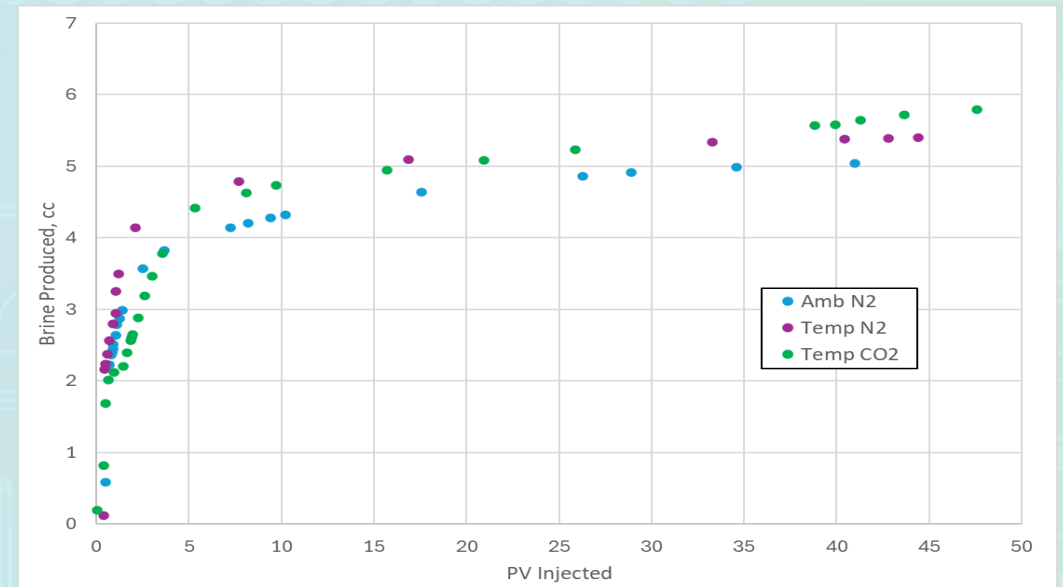
Procedure

- **Samples were cleaned and dried.**
- **Routine core properties were measured.**
- **Samples saturated with 100K ppm sodium chloride (NaCl) brine.**
- **Specific permeability to brine (K_w) was measured.**
- **USS relative permeability measured**
 - **N₂-displacing-brine at ambient conditions**
 - **N₂-displacing-brine at 150°F, 1500 psi NCS, and 1500 psi (pore pressure)**
 - **CO₂-displacing-brine at 150°F, 1500 psi NCS, and 1500 psi (pore pressure)**

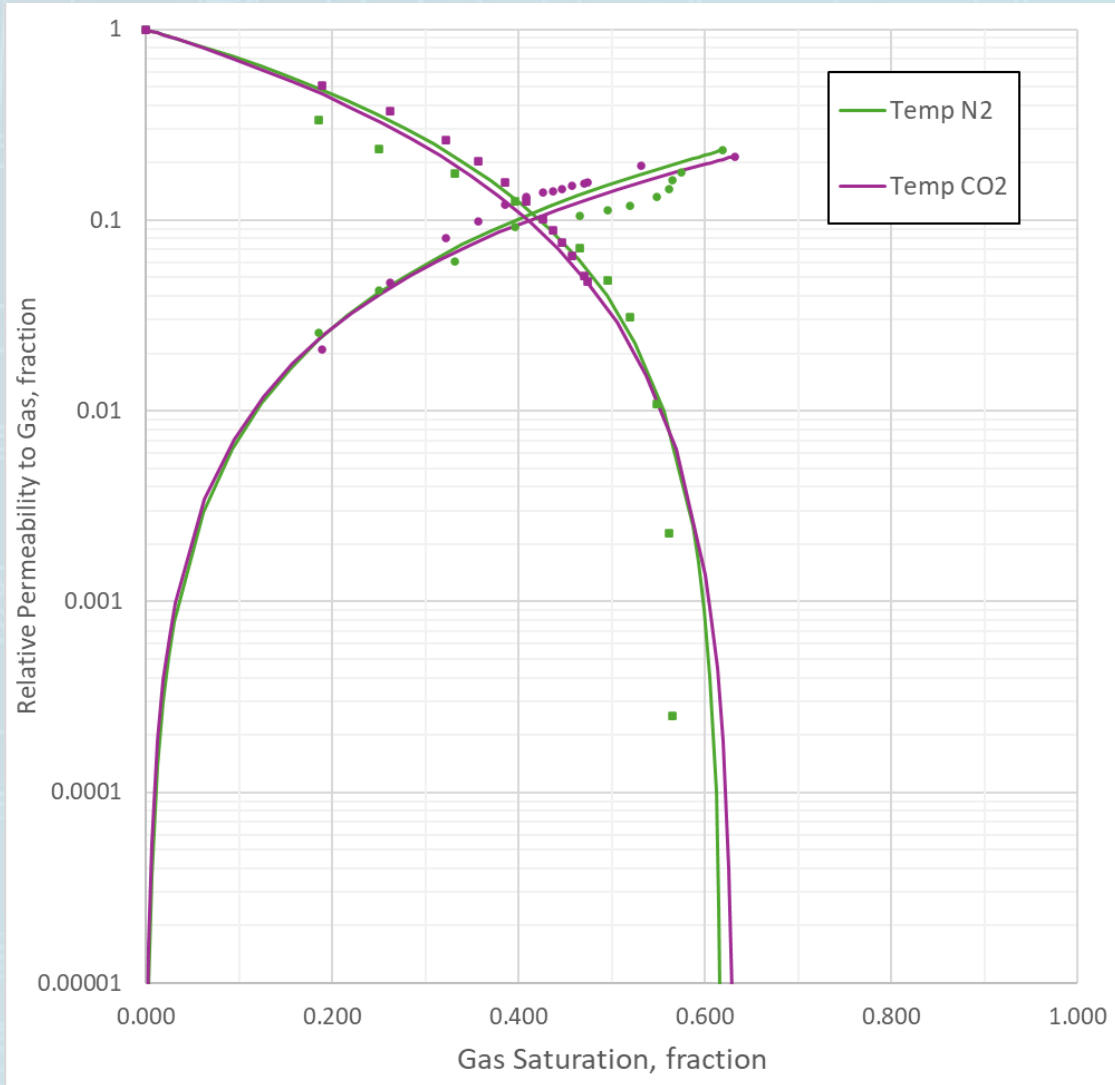
Results - Nugget



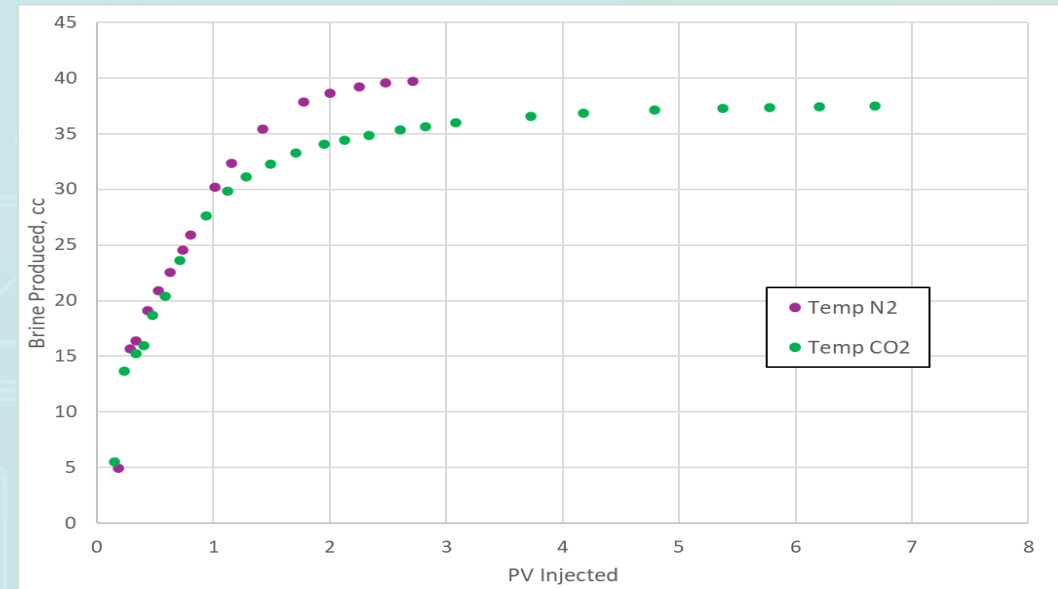
Sample	Initial Conditions		Rate	Terminal Conditions		Recovery
	Specific Kw, md	Sw, fraction		Sg, fraction	Krg	
Amb N2	71.7	1.00	Initial	0.516	0.091	0.516
			Bump	0.566	0.129	0.566
Temp N2	71.7	1.00	Initial	0.587	0.135	0.587
			Bump	0.624	0.218	0.624
Temp CO2	71.7	1.00	Initial	0.622	0.113	0.622
			Bump	0.663	0.224	0.663



Results - Bentheimer



Sample	Initial Conditions		Rate	Terminal Conditions		Recovery
	Specific Kw, md	Sw, fraction		Sg, fraction	Krg	
Temp N2	2650	1.00	Initial	0.575	0.179	0.575
			Bump	0.618	0.232	0.618
Temp CO2	2600	1.00	Initial	0.532	0.193	0.532
			Bump	0.632	0.216	0.632



Ongoing Analysis & Future Work

- **Testing on additional rock types and varying quality**
- **Relative permeability from Pc Analysis**
- **Digital Rock Analysis**

Conclusions

- **CO₂ relative permeability testing poses numerous challenges. The challenges are compounded with the steady-state displacement process**
- **In two (2) different rock types of varying quality, N₂ and CO₂ showed similar behavior in drainage relative permeability**
- **Further testing at various testing conditions is required to develop a full suite of results for comparison**

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