Department of Physics and Technology

CO_2 Foam Pilot Test

East Seminole

Zachary Paul Alcorn, Tore Føyen, Metin Karakas, Leilei Zhang, George Hirasaki, and Arne Graue

CO_2 EOR as CCUS Conference
September 26, 2019

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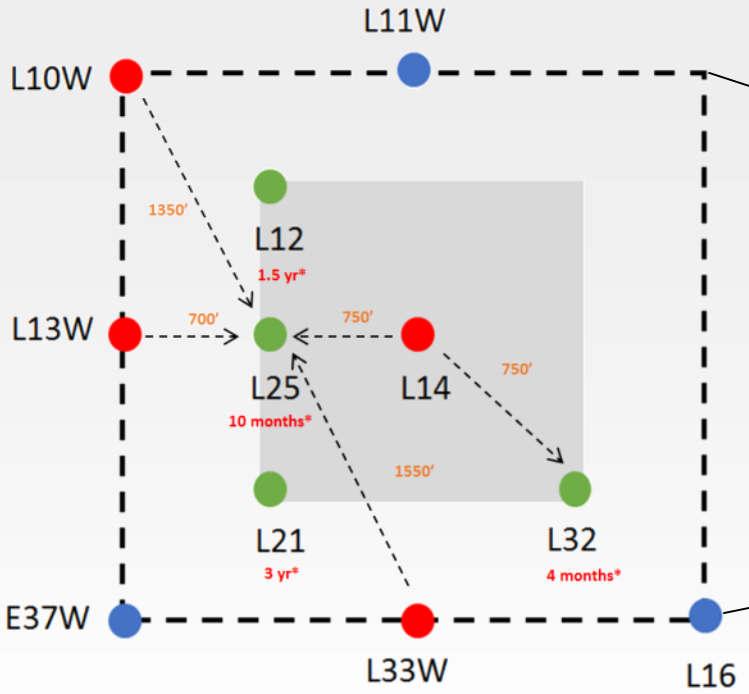
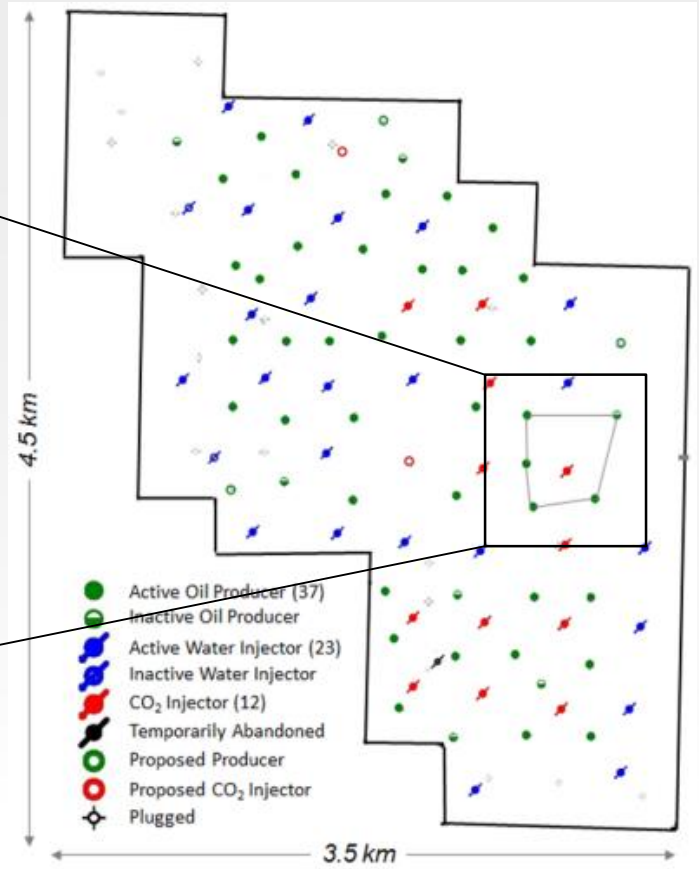
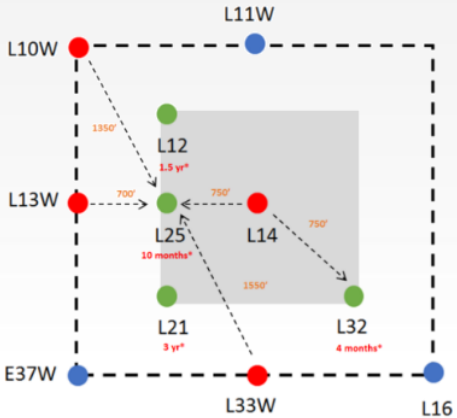
Pilot Pattern





Overview

	Laboratory	Field
Site	reservoir cores	inverted 40 acre 5-spot
Surfactant	nonionic Huntsman L24-22 (water soluble)	
Foam System	0.5 wt% concentration at 70% foam quality	
EOR	24-36% Incr. OOIP	
Injection Strategy	multi-cycle SAG 10 days surfactant solution, 20 days CO_2	



Field Objectives

1. Verify *in-situ* foam generation and CO_2 mobility control

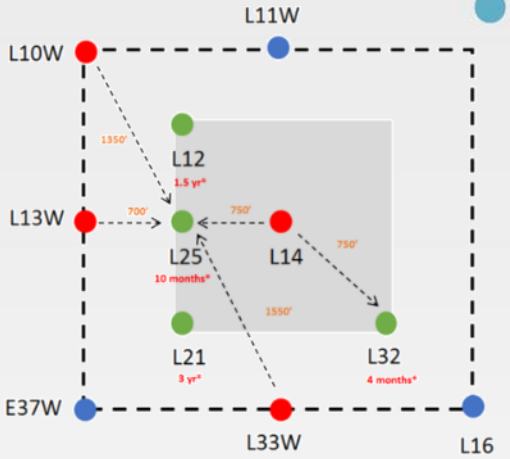
2. Increase oil production through improved CO_2 sweep efficiency

3. Implement large scale transportation, mixing, and injection of surfactant

Baseline data collection and pilot monitoring
Surface facilities and chemical additives

Data Collection and Monitoring

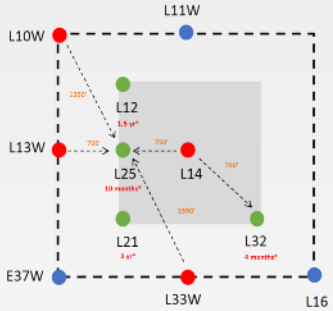
- Interwell Connectivity
- Injection Profiling
- Fluid Monitoring
- Injection and Production Monitoring
- Corrosion

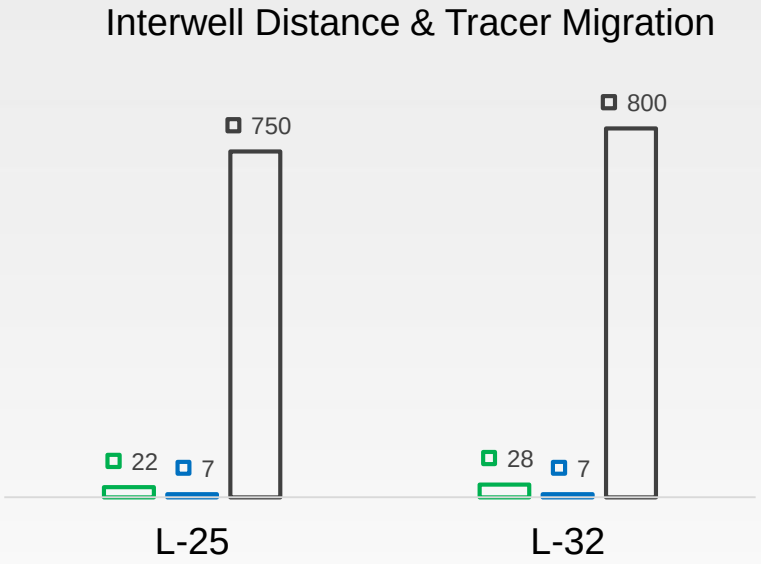


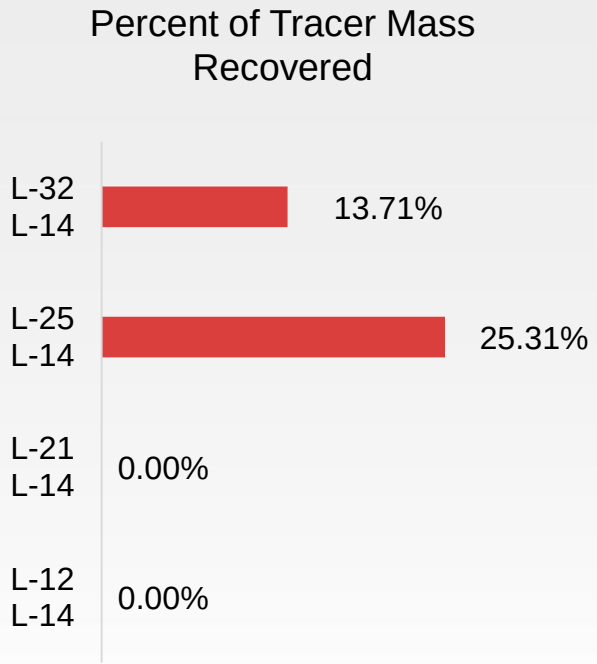
Stage	Pre SAG (baseline)	Pilot Phase (12 SAG Cycles)						Post SAG
Slug	CO_2 Injection	Surfactant	CO_2	Surfactant	CO_2	Surfactant	CO_2	
Tracers	CO_2 (L14)							CO_2 (L14)
Injection Profiles (L14)	✓				✓			✓
Down hole measurement (L14)	✓				✓			✓

Characterizing Interwell Connectivity

Tracer Test – CO_2

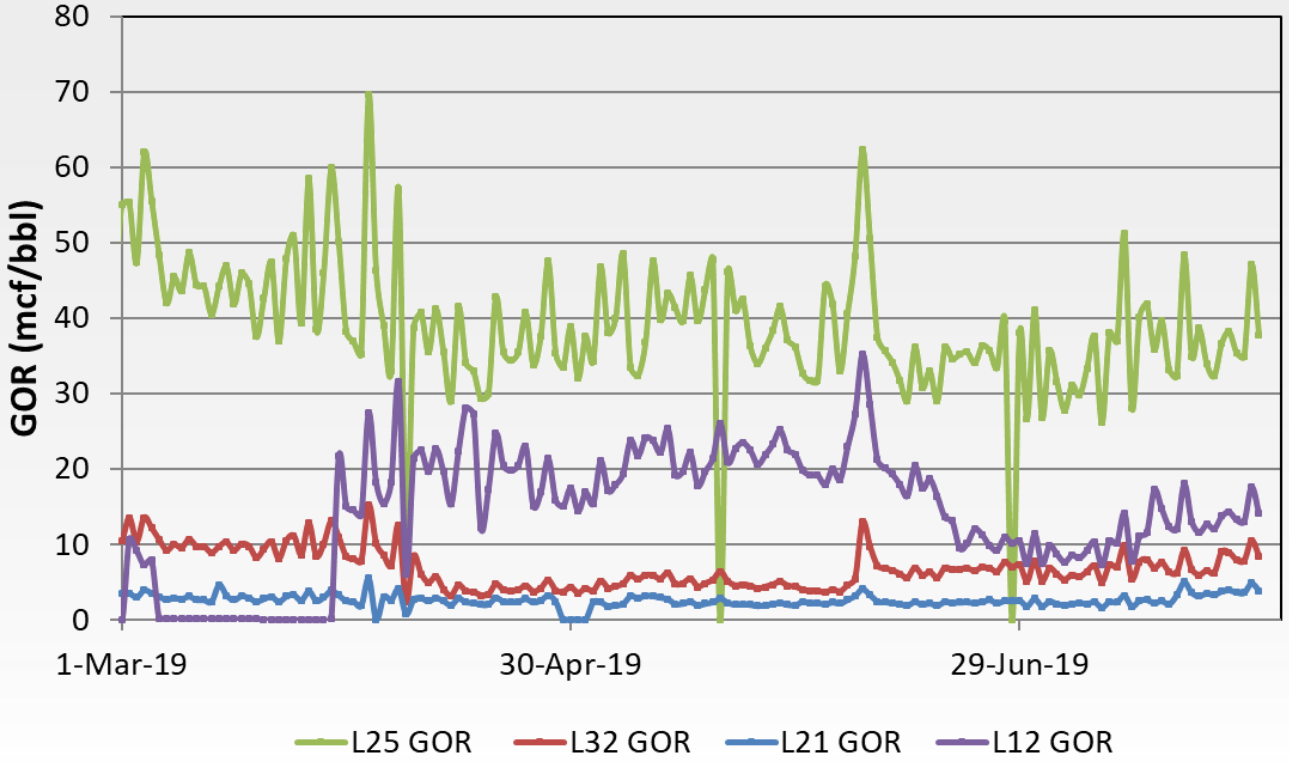


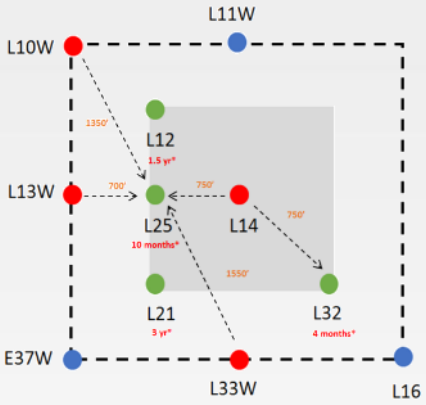


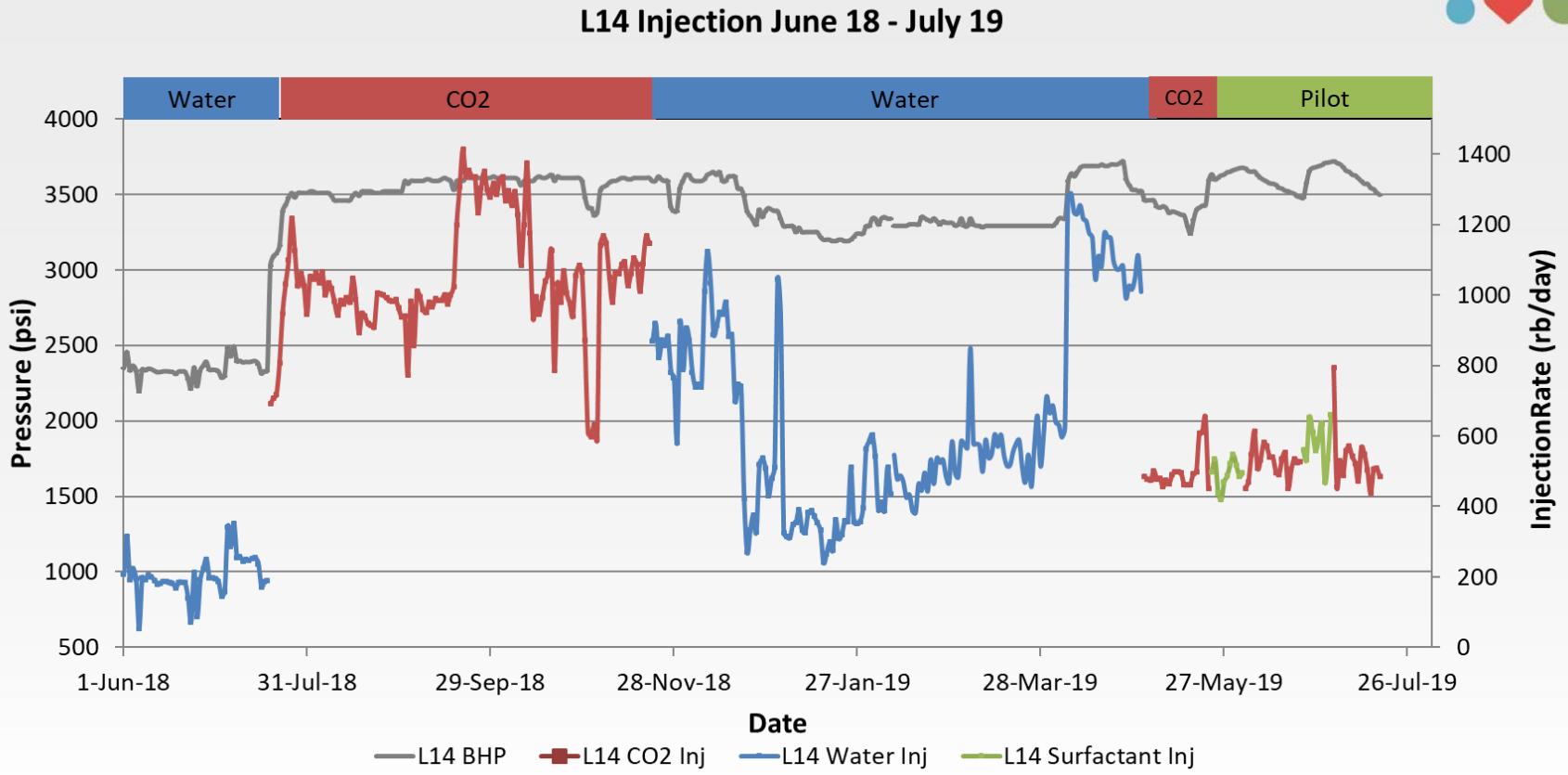


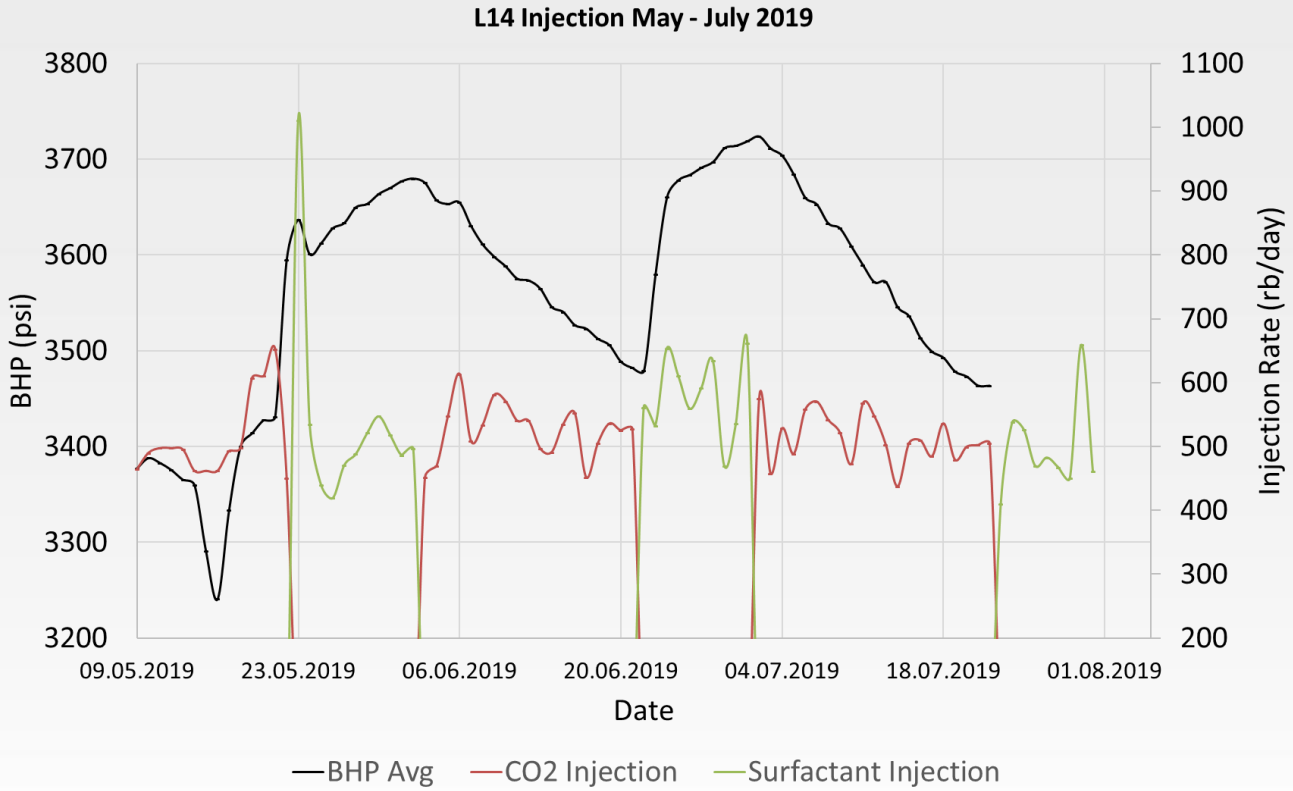
Injection and Production Monitoring

Pattern Producing GOR March -July 19



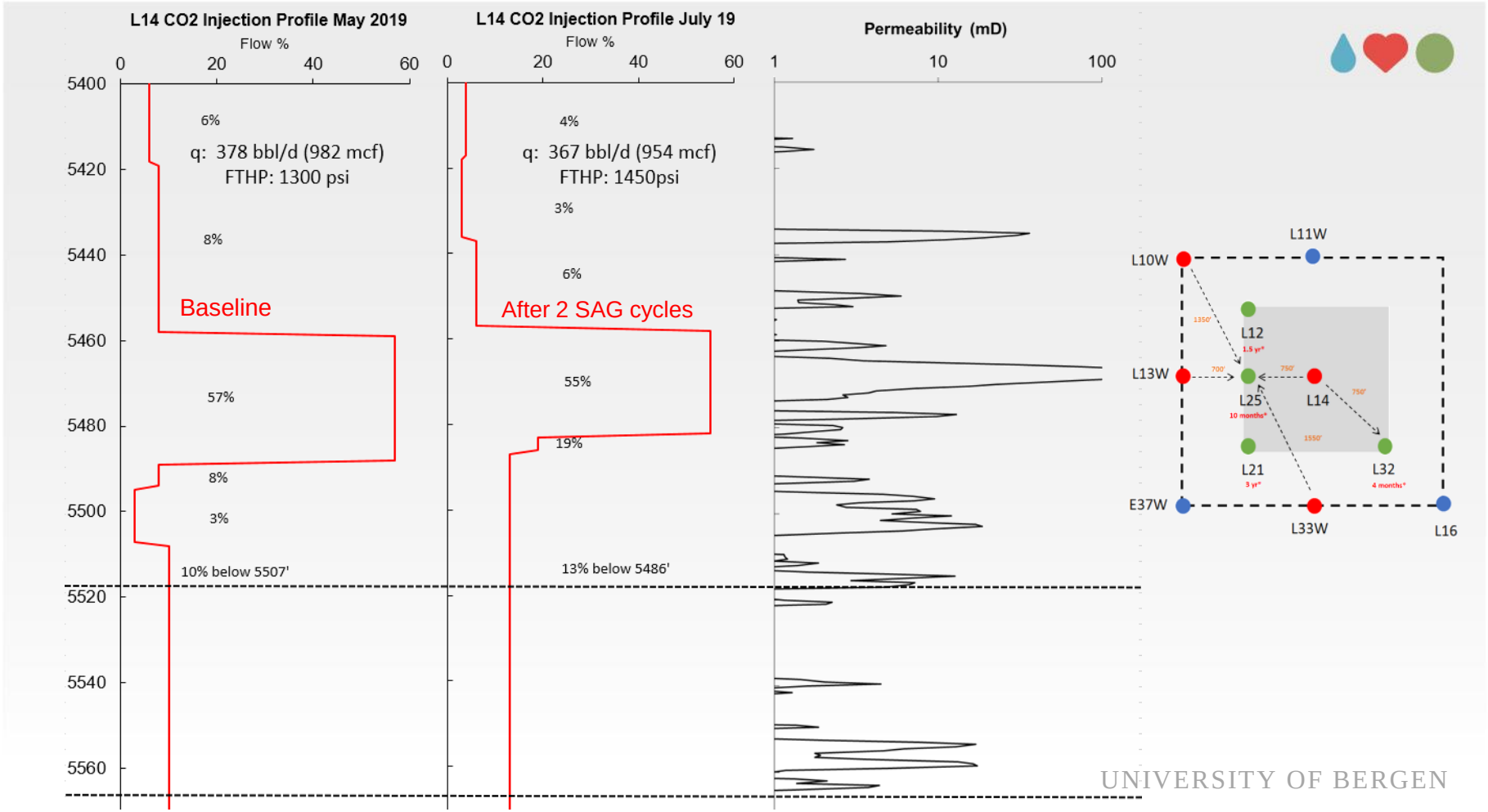



L14 Injection June 18 - July 19
Water
CO2
Water
CO2
Pilot
Pressure (psi)
4000
3500
3000
2500
2000
1500
1000
500
InjectionRate (rb/day)
1400
1200
1000
800
600
400
200
0
1-Jun-18
31-Jul-18
29-Sep-18
28-Nov-18
27-Jan-19
28-Mar-19
27-May-19
26-Jul-19
Date
L14 BHP
L14 CO2 Inj
L14 Water Inj
L14 Surfactant Inj



- 100 to 200 psi BHP increase during surfactant slugs
- BHP decrease during CO_2 slugs

Injection Profiles


L14 CO2 Injection Profile May 2019
Flow %
0
20
40
60
5400
5420
5440
5460
5480
5500
5520
5540
5560
6%
q: 378 bbl/d (982 mcf)
FTHP: 1300 psi
8%
Baseline
57%
8%
3%
10% below 5507'
L14 CO2 Injection Profile July 19
Flow %
0
20
40
60
4%
q: 367 bbl/d (954 mcf)
FTHP: 1450psi
3%
6%
After 2 SAG cycles
55%
19%
13% below 5486'
Permeability (mD)
1
10
100
L11W
L10W
L12
1.5 yr*
L13W
L25
10 months*
L14
L21
3 yr*
L32
4 months*
E37W
L33W
L16
1350'
700'
750'
750'
1550'

Surface Facilities

Subsurface steel CO_2 pipe

Acknowledgements

Norwegian Research Council **CLIMIT Program** for financial support under grant number 249742 - *CO_2 Storage from Lab to On-Shore Field Pilots Using CO_2 Foam for Mobility Control in CCUS*

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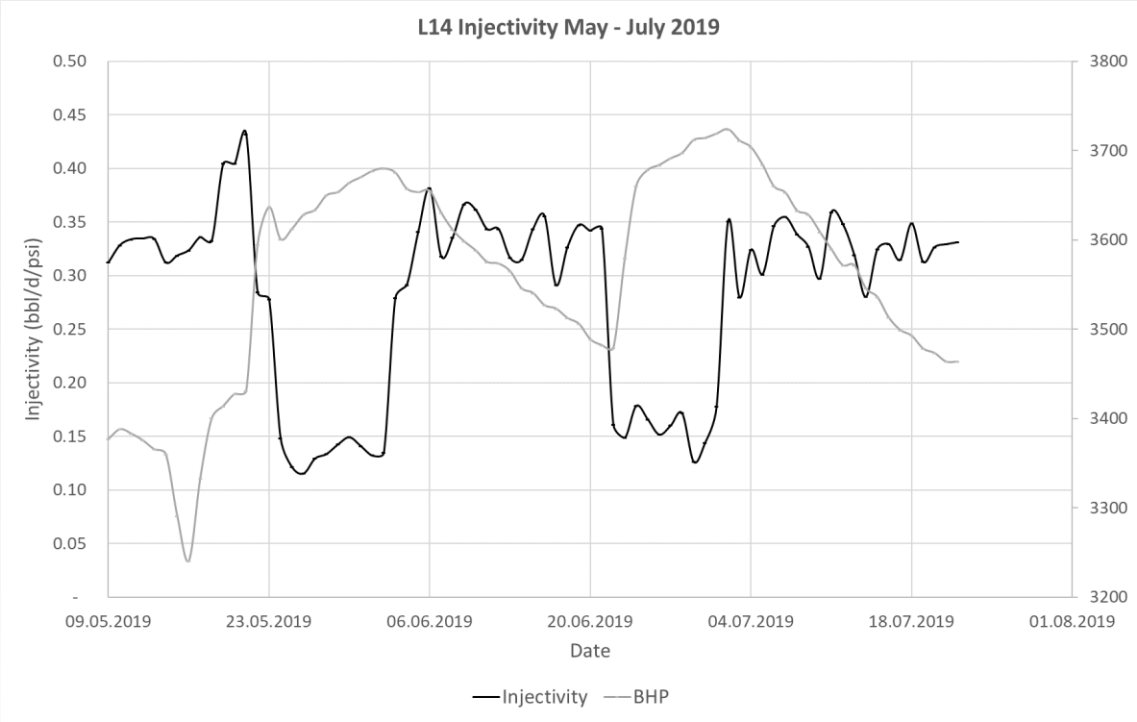
L14 Injectivity May - July 2019
Injectivity (bbl/d/psi)
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
-
3800
3700
3600
3500
3400
3300
3200
09.05.2019
23.05.2019
06.06.2019
20.06.2019
04.07.2019
18.07.2019
01.08.2019
Date
Injectivity
BHP