



Wellbore Interconnectivity at FORGE

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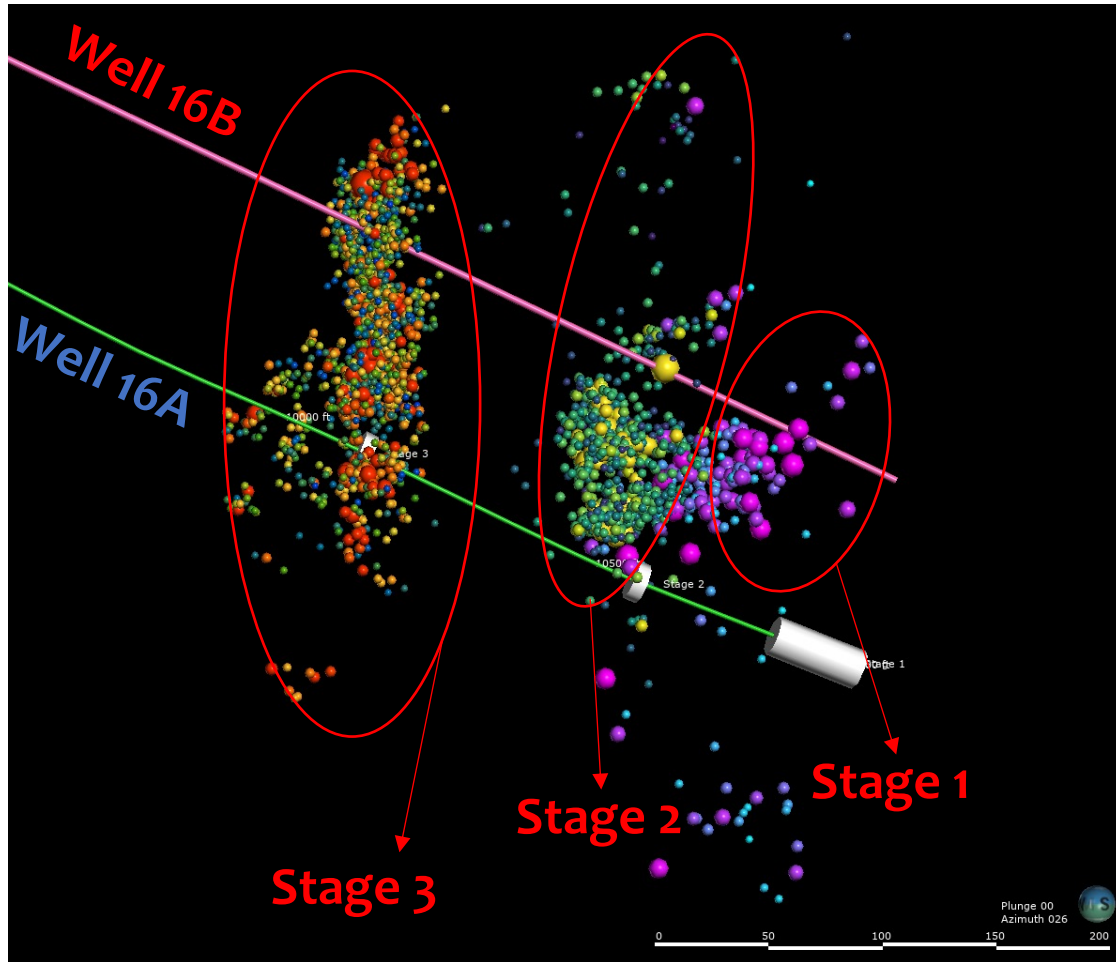


Timeline

- Completed **drilling well 16A(78)-32** in December **2020**
- Conducted three stage **stimulation** in well **16A(78)-32** in April **2022**
- Completed **drilling** production well **16B(78)-32** into microseismic cloud of the stimulations in June **2023**
- Conducted **circulation tests** and **demonstrated the connection** between 16A(78)-32 and 16B(78)-32 in July **2023**

Background

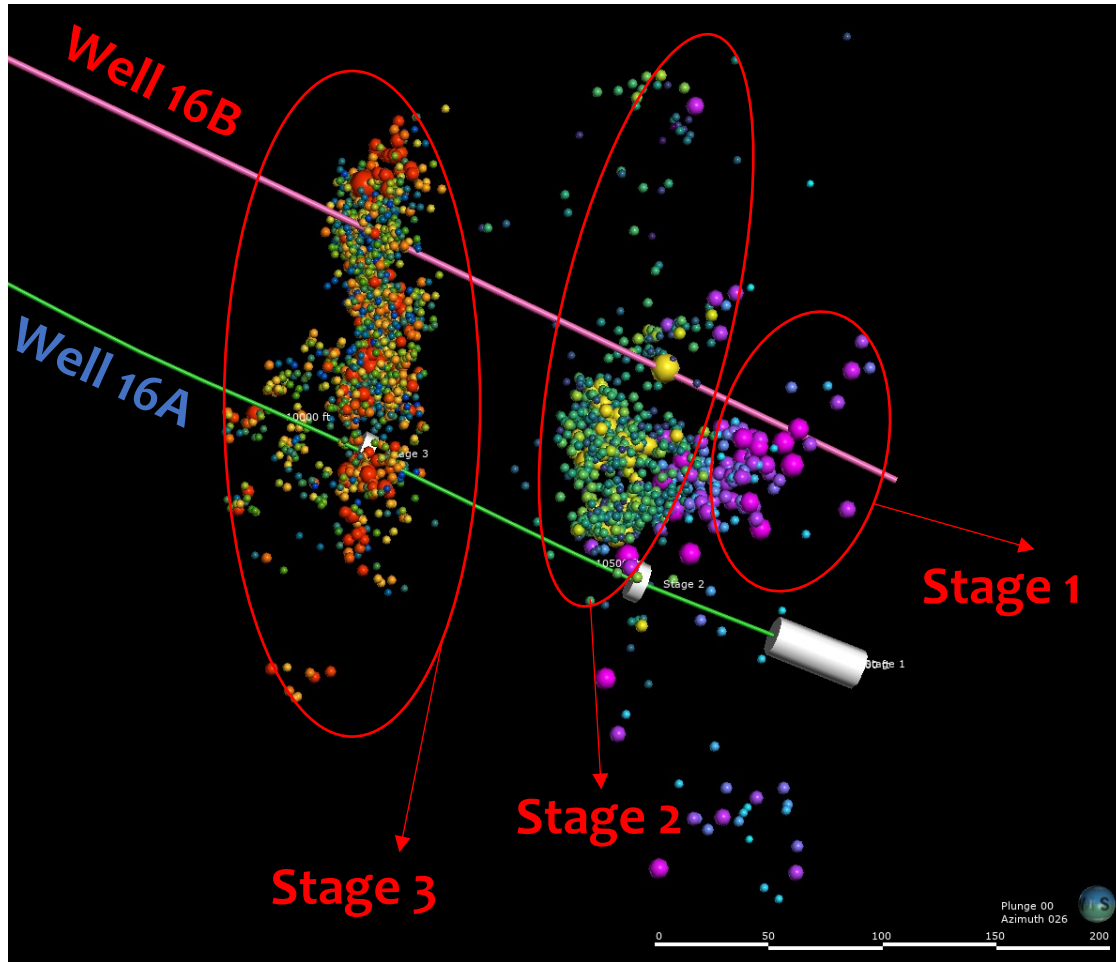
Three stages of stimulation near the toe of the injection well 16A(78)-32



Stage No.	Treating fluid	Maximum pumping rate (bpm)	Pumped volume (bbl)	Completion
1	Slickwater	50	4261	Openhole
2	Slickwater	35	2777	Cased
3	Crosslink gel	35	3016	Cased

Field stimulation microseismicity
Hari Neupane at INL using Leapfrog Geothermal

Background

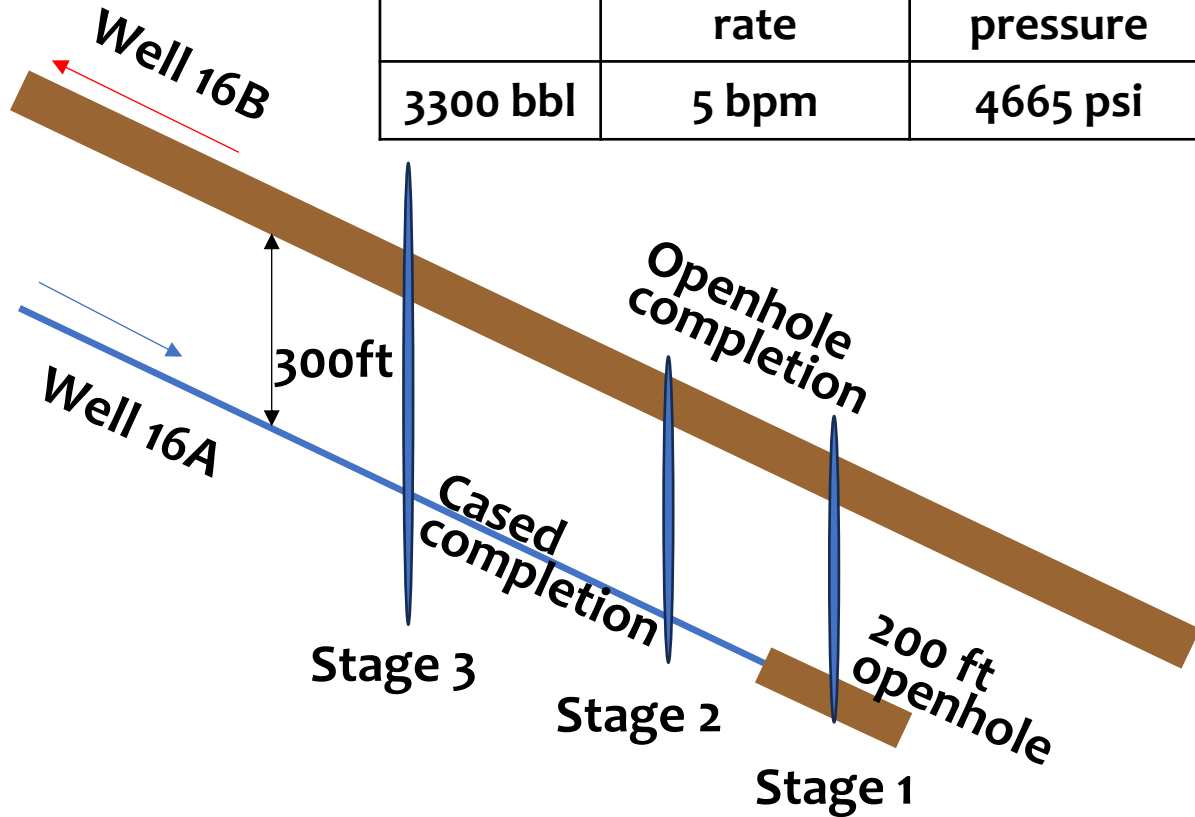


after Neupane, 2023

- Hydraulic stimulation in the injection well 16A(78)-32 in April 2022 (~10,000 bbl injected in total) created a **fracture network**, combination of newly created fractures and natural fractures
- Production well 16B(78)-32 was drilled to the **microseismic clouds** from the stimulation
- **Connection** between wells 16A(78)-32 and 16B(78)-32 can be **demonstrated by circulation test** through pressure response and fluid communication

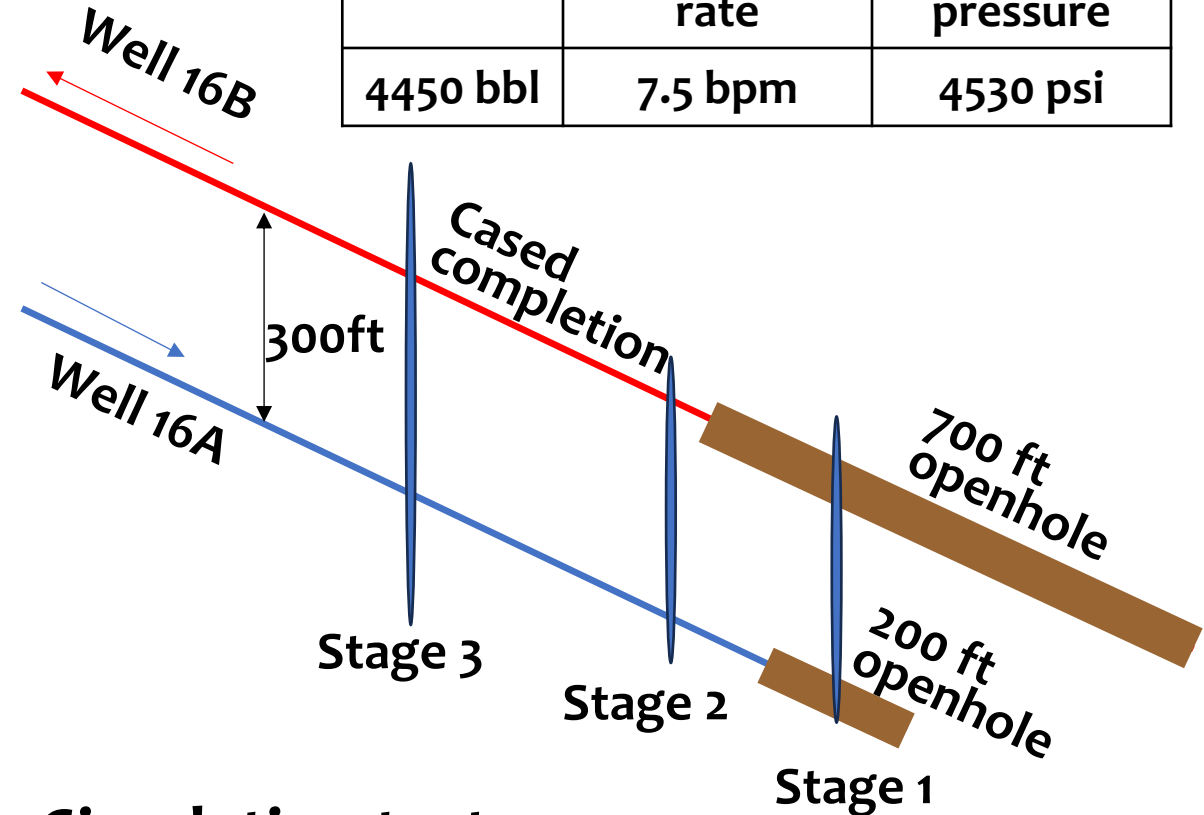
Circulation Tests Description

Injected volume	Maximum pumping rate	Maximum surface pressure
3300 bbl	5 bpm	4665 psi



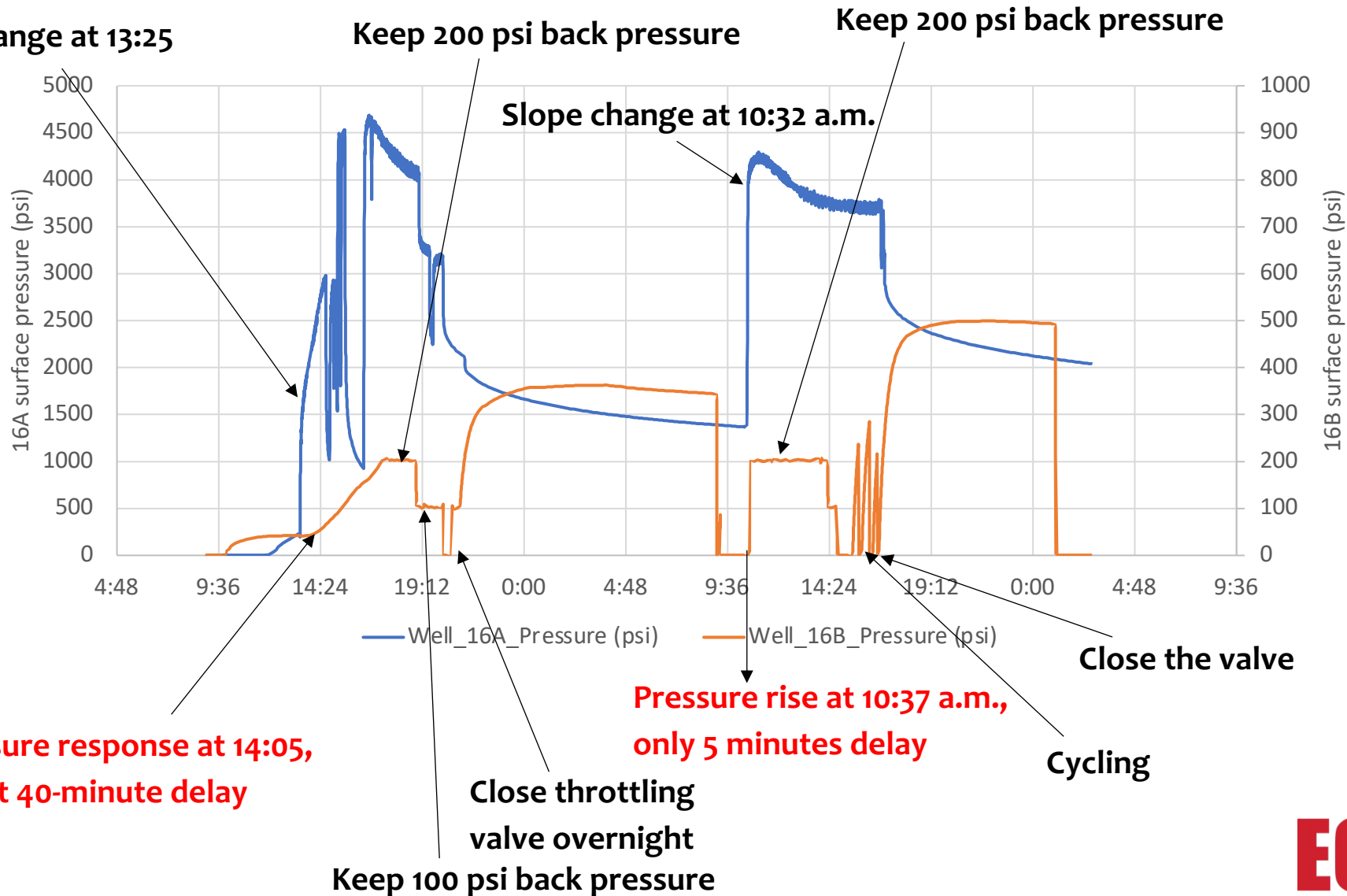
Circulation test 1
 July 4th and 5th 2023

Injected volume	Maximum pumping rate	Maximum surface pressure
4450 bbl	7.5 bpm	4530 psi



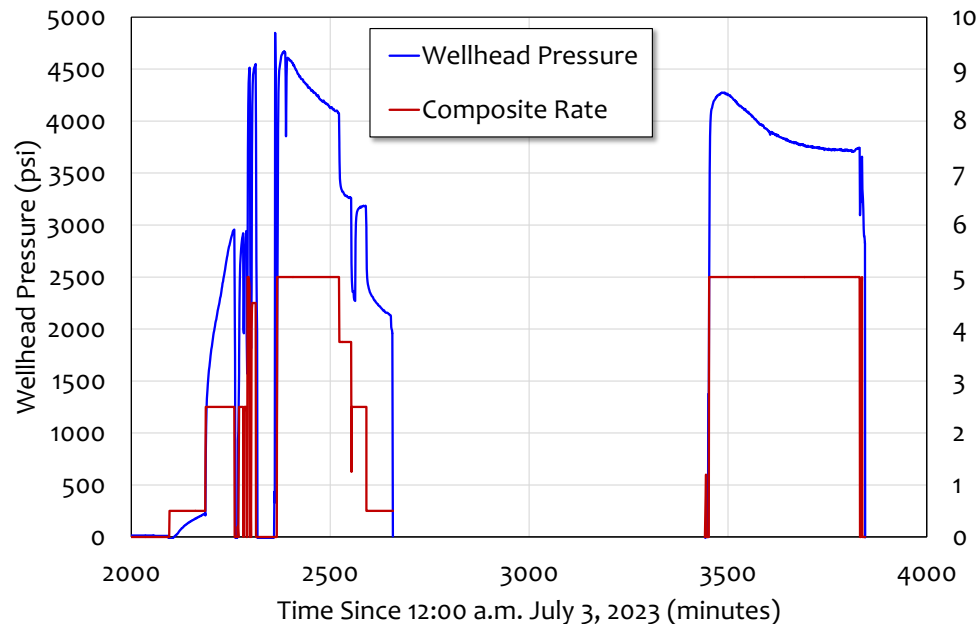
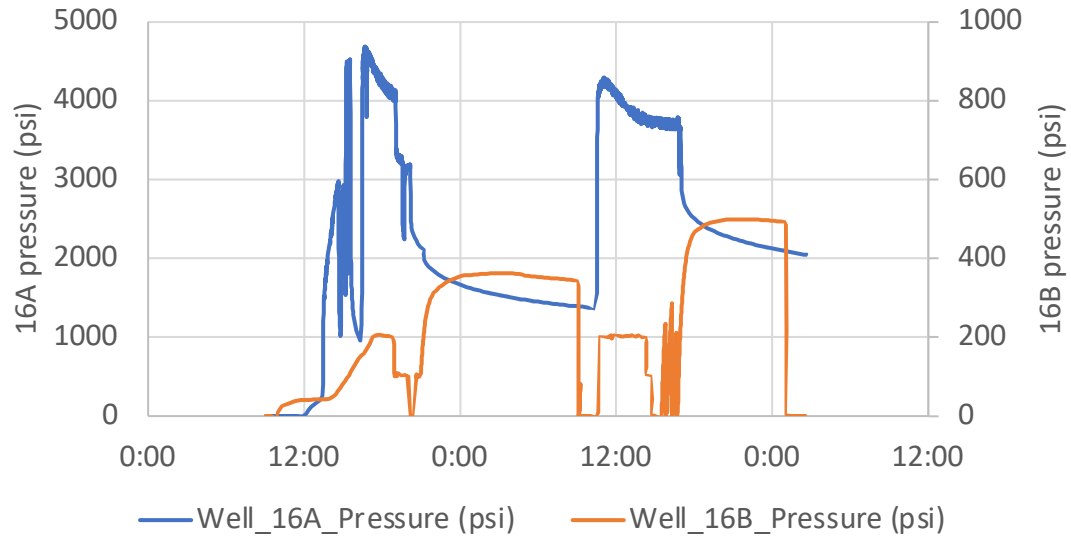
Circulation test 2
 July 18th and 19th 2023

Circulation Test 1



- Pressure change in Well 16B(78)-32 shows the connection
- Pressure response in Well 16B(78)-32 – 40-minute delay on July 4th and 5-minute delay on July 5th circulation

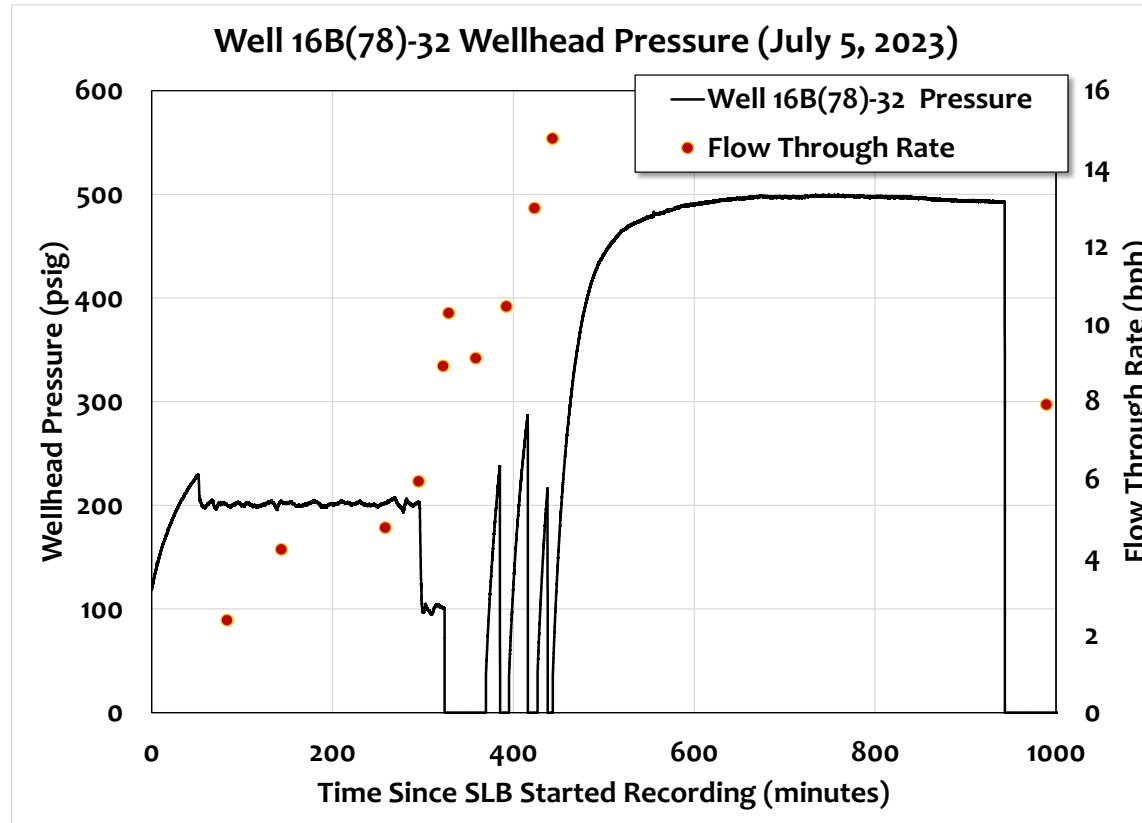
Circulation Test 1



- Wellhead pressure at Well 16A(78)-32 is above the fracturing pressure (corresponding pressure is 3000 psi surface pressure)
- For the July 5th circulation stage
 1. re-initiation/reopening pressure is smaller,
 2. shut-in pressure is higher (more fluid in the reservoir),
 3. Well 16B(78)-32 pressure is higher

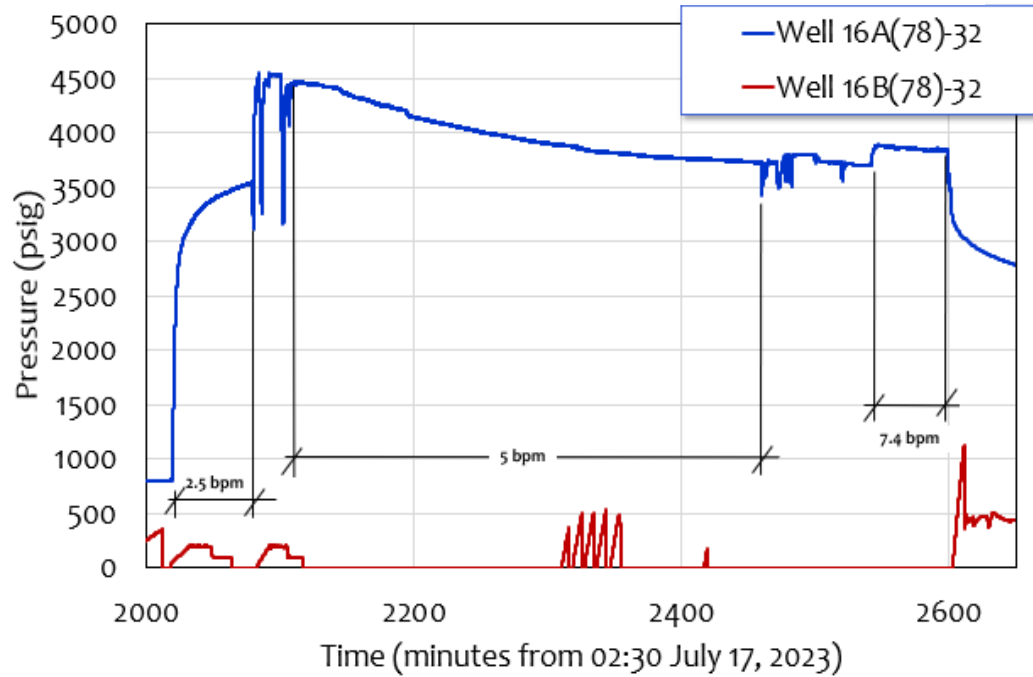
Circulation Test 1, Day 2 – July 5, 2023

- Production in 16B demonstrated connection (rate is in the order of 10 bbl per hour)
- Production rate increased with water volume pumped into the injection well - 16A(78)-32

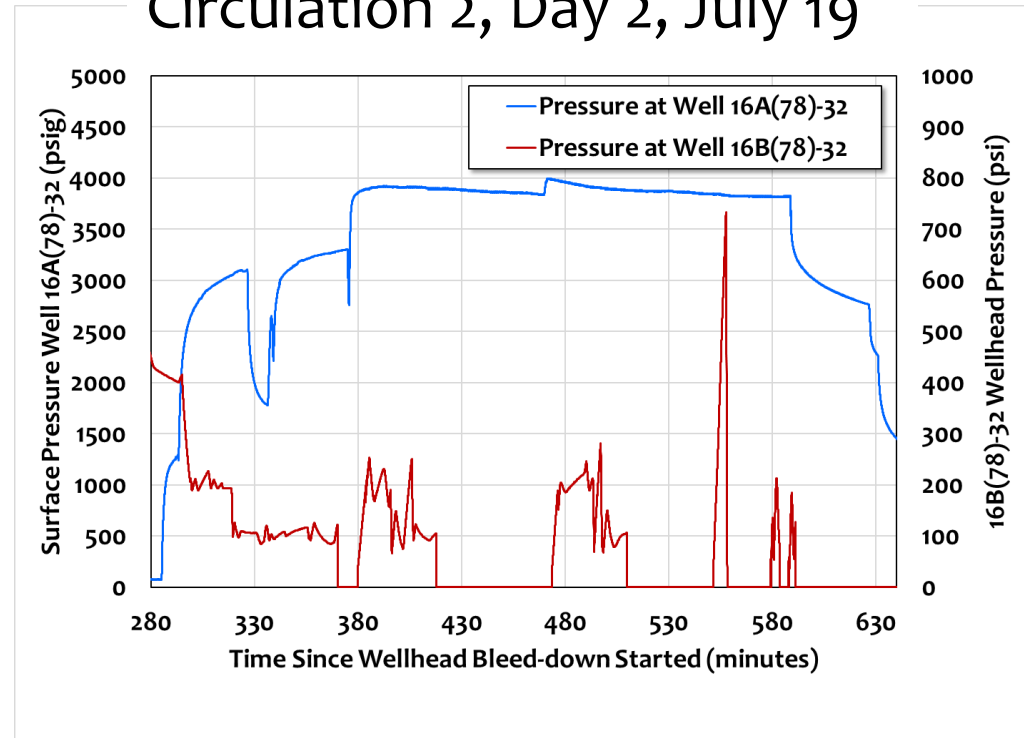


Circulation Test 2

Circulation 2, Day 1, July 18



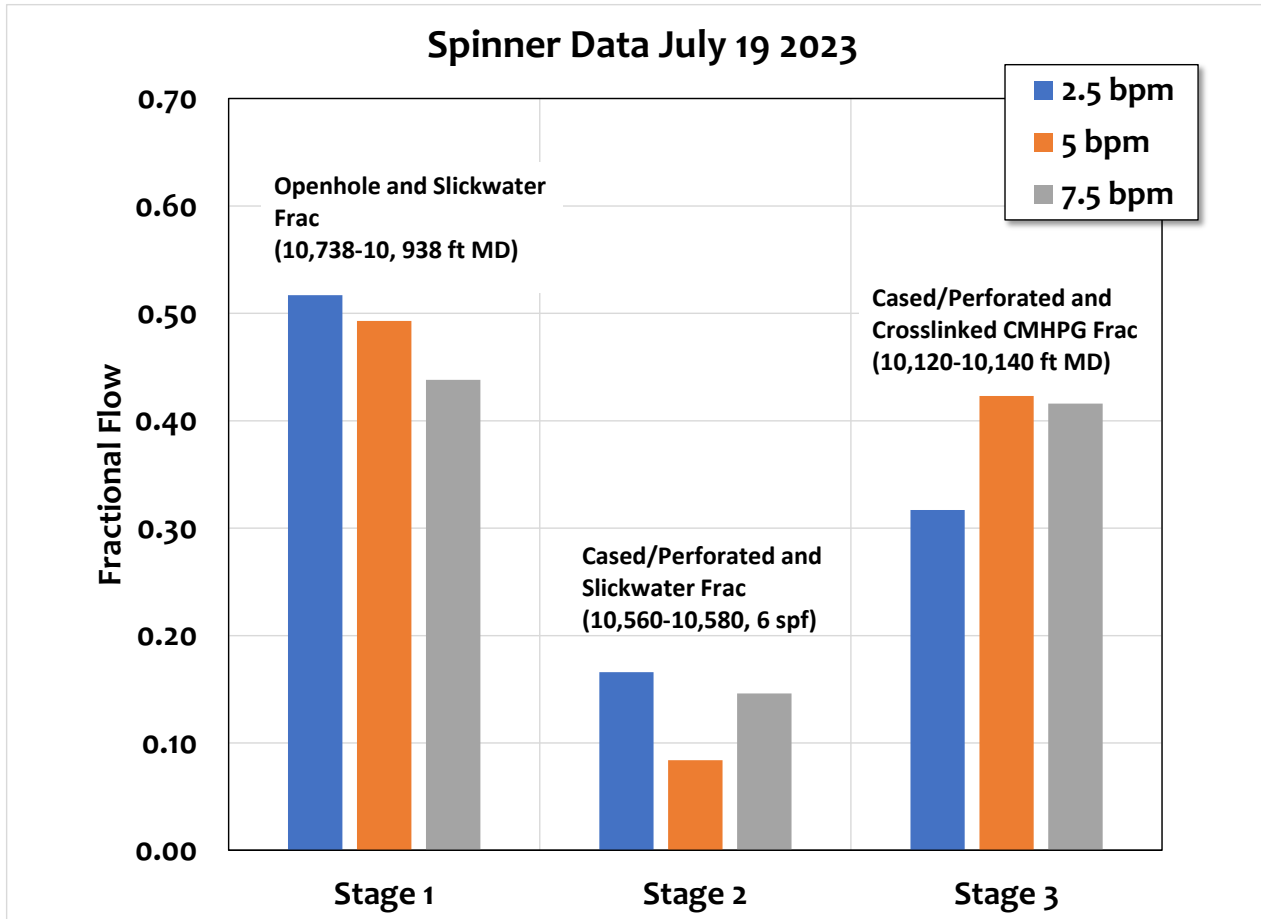
Circulation 2, Day 2, July 19



- Instantaneous response in Well 16B(78)-32 for both July 18th and 19th
- Treatment pressure is lower for the July 19th circulation

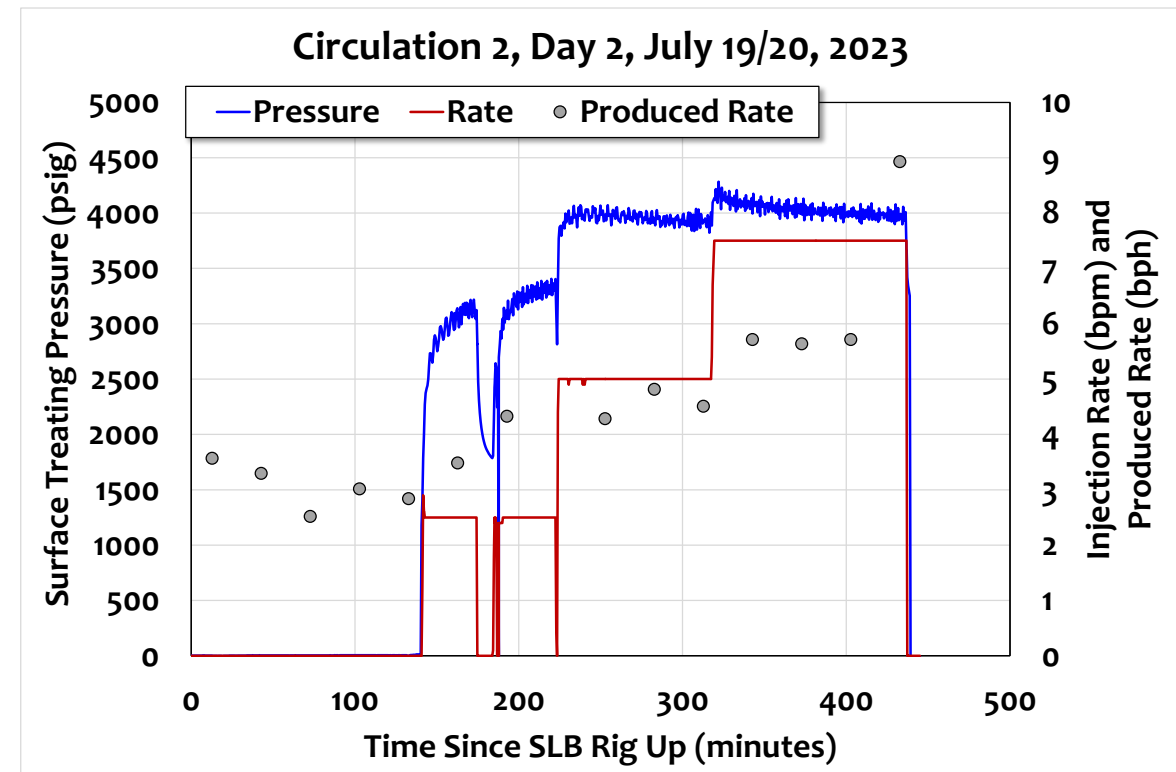
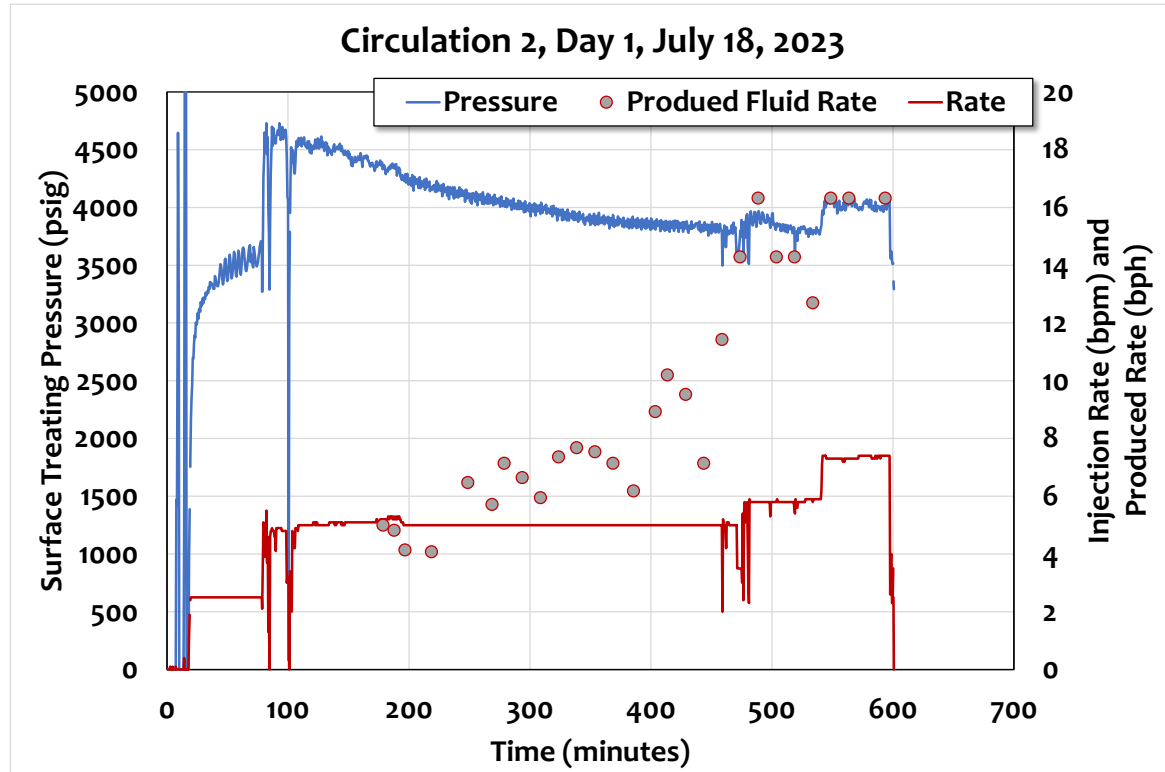
Circulation Test 2 – July 19 and 20, 2023

Spinner Test Results



- **Stage 1** (openhole, treated with slickwater) and **Stage 3** (cased and perforated, treated with crosslinked gel) take much **more fluid than Stage 2** (cased and perforated, treated with slickwater)

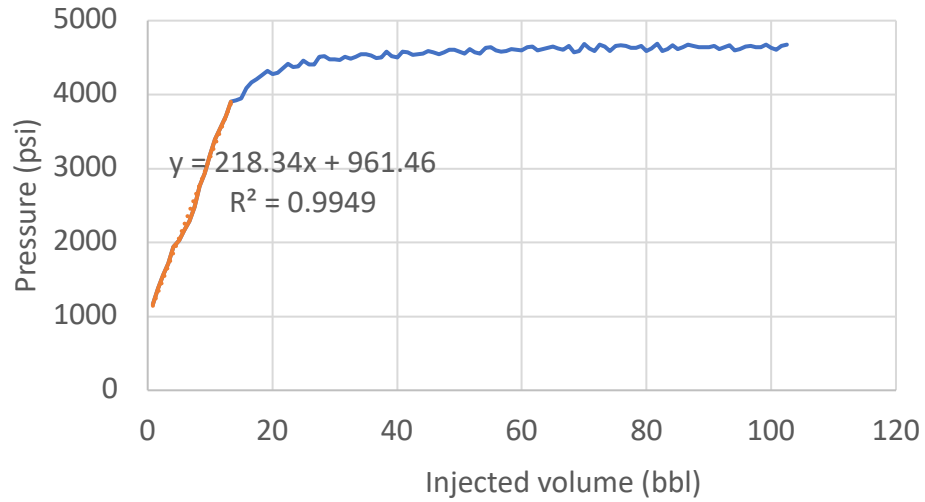
Circulation Test 2



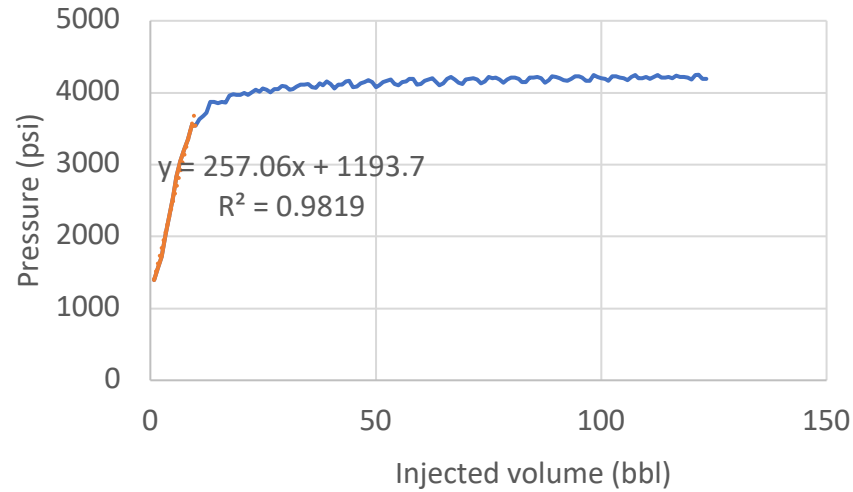
- Production rate for all the circulation tests is around 5 -15 bph.
- Actual production rate could be larger for Test 2, because the Stage 3 and potentially Stage 2 connection are behind the casing, which probably accounts for 50% of the flow.

Stiffness Evolution

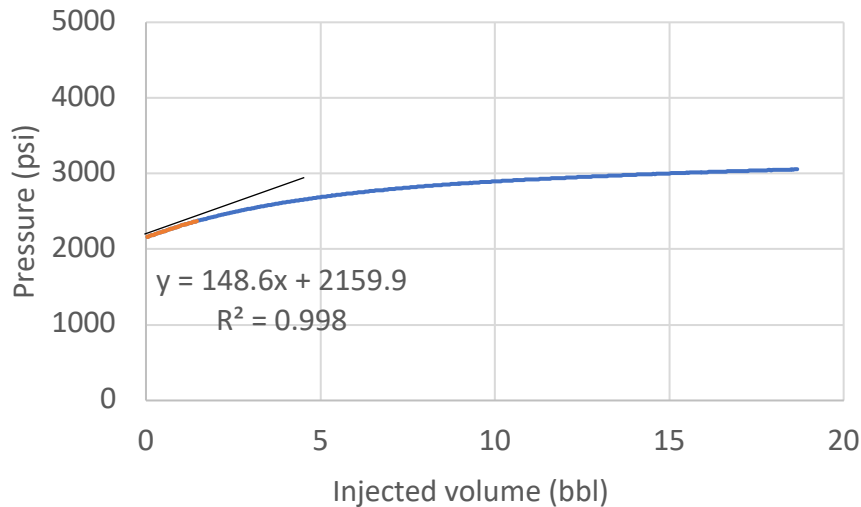
July 4th 5bpm stiffness



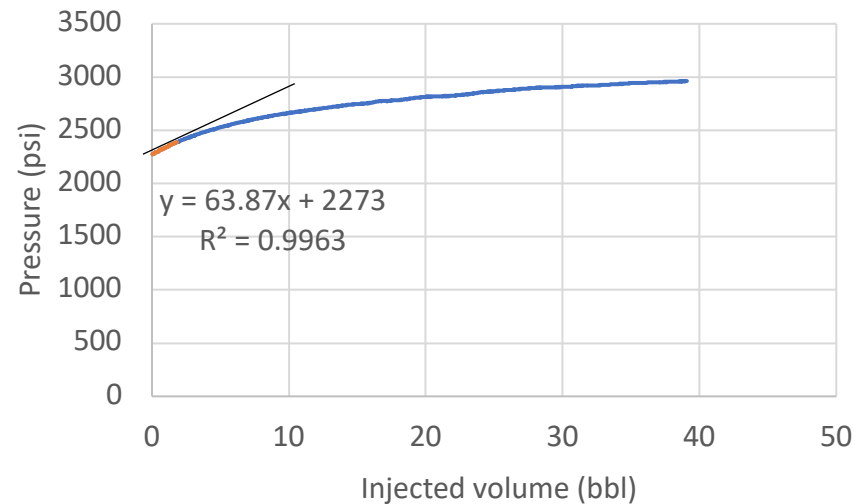
July 5th 5 bpm stiffness



July 18th 2.5 bpm stiffness



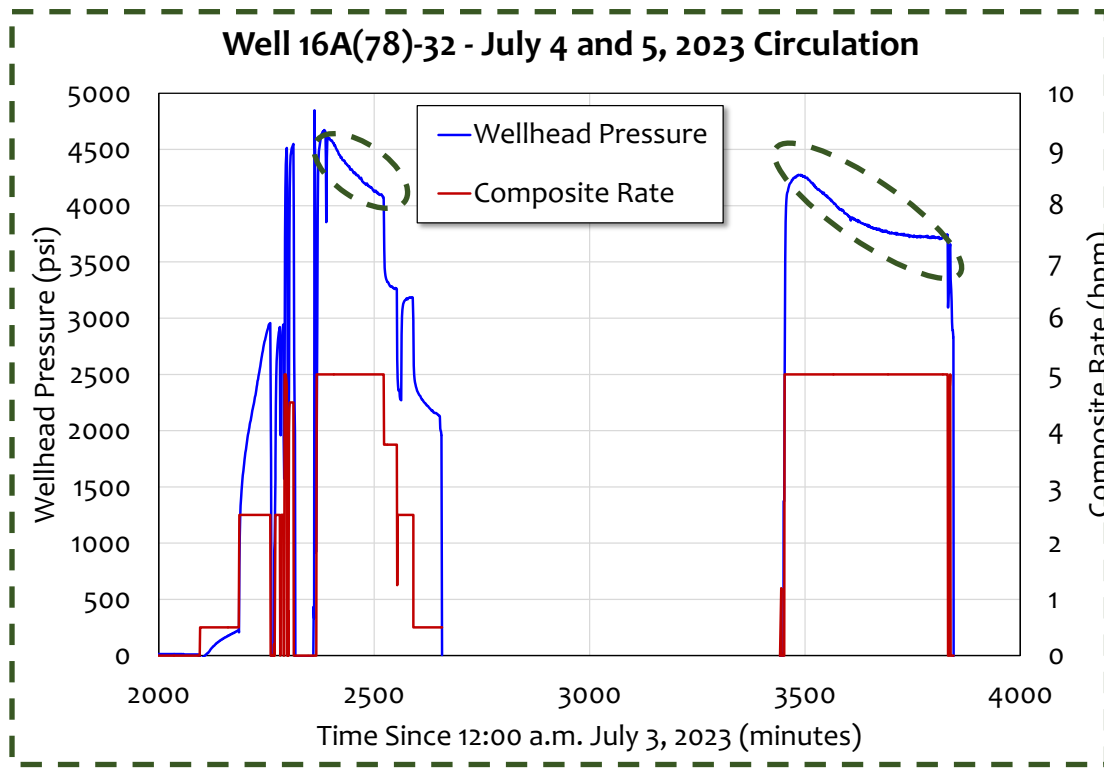
July 19th 2.5 bpm stiffness



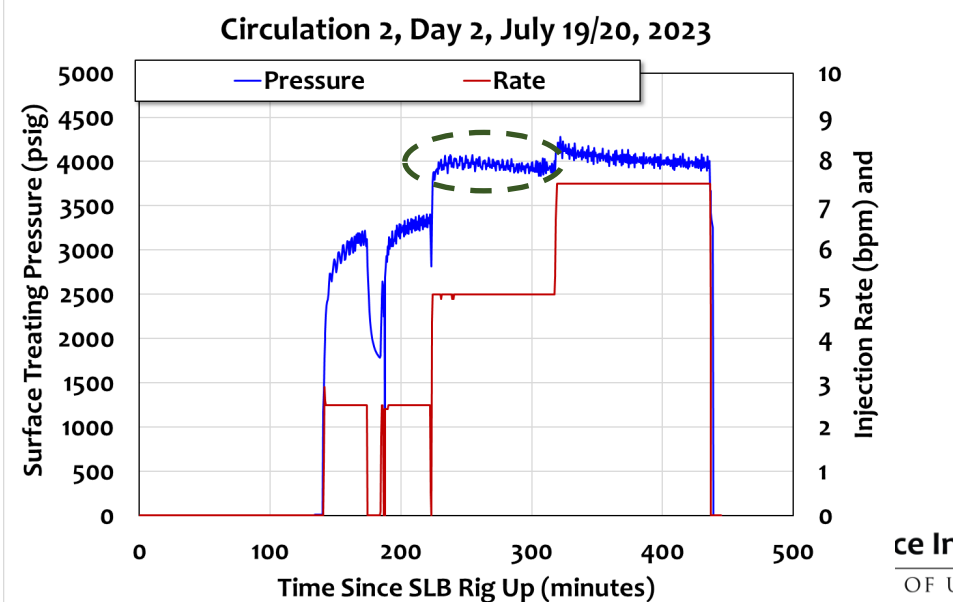
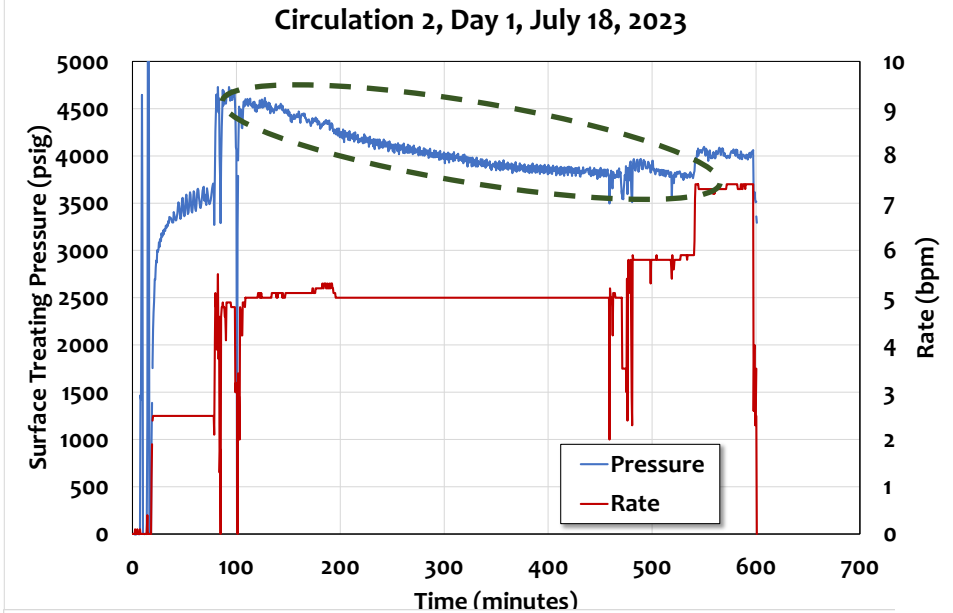
Circulation	Stiffness (psi/bbl)
July 4th	218
July 5th	257
July 18th	149
July 19th	64

Stiffness was much reduced in the July 18th and 19th circulation test

Pressure Profile Comparison



- Flat injection pressure trend and lower pressure on July 19th circulation suggests **higher conductivity**
- Could be due to hours of flowback from Well 16A(78)-32 before the injection on July 19th



Conclusions

1. A connection was definitively established (pressure response and production from Well 16B(78)-32).
2. Injection pressure is above the minimum in situ principal stress.
3. Stimulation previously established a fracture network.
4. Initial cycles showed pressure decline suggesting fracture reopening and potential fracture propagation.
5. Last cycle showed flat pressure trend suggested a connected channel between two wells (precipitation removal due to flowback?).
6. Proppant will be a prerequisite for future treatments.
7. Communication that can be improved with sustained injection into Well 16A(78)-32 (reduced system stiffness and injection pressure)