Developing CO_2-EOR and Associated Storage within the Residual Oil Zone Fairways of the Powder River Basin, Wyoming

DE-FE0031738

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Presentation Outline

1. Project Overview
2. Project Background
3. Technical Approach
4. Current Project Status
5. Next Steps

Project Overview: Key Participants

NATIONAL ENERGY TECHNOLOGY LABORATORY

University of Wyoming
School of Energy Resources
Enhanced Oil Recovery Institute

Advanced Resources International

Contango

Core Lab
RESERVOIR OPTIMIZATION

Melzer CO_2nsulting

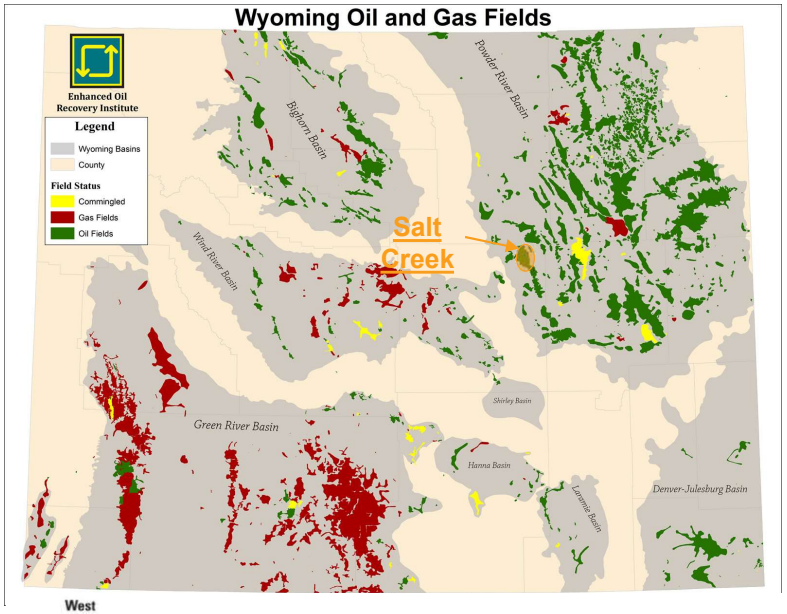
Project Overview: Objectives

1. Characterize the residual oil zone (ROZ) fairway at Salt Creek
   - Establish a Field Laboratory in ROZ fairway
2. Review of mechanisms of ROZ-associated CO_2 storage
3. Examine alternative CO_2 injection and storage strategies
4. Determine economic viability of the combined CO_2-EOR and CO_2 storage in the Salt Creek ROZ

DOE:
$2.8 million
Cost share: 1.6 million

Project Background: Salt Creek Field

- 1.7 billion bbl oil originally in place
- 732 million bbl produced from 4000+ wells
- CO_2-EOR since 2003
- WC1 and WC2 are main producing formations
- Potentially extensive ROZ in WC1



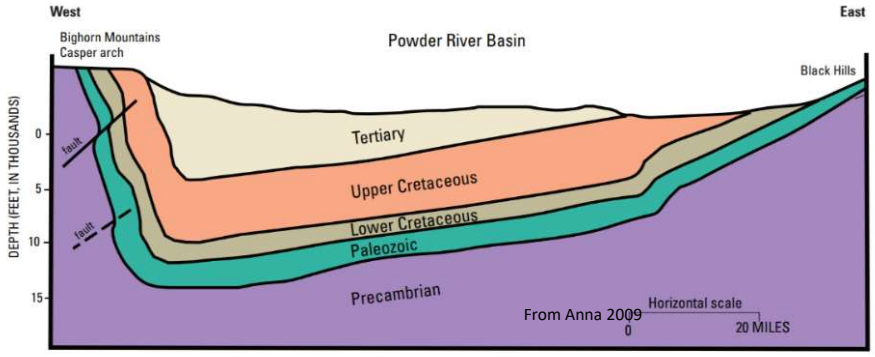
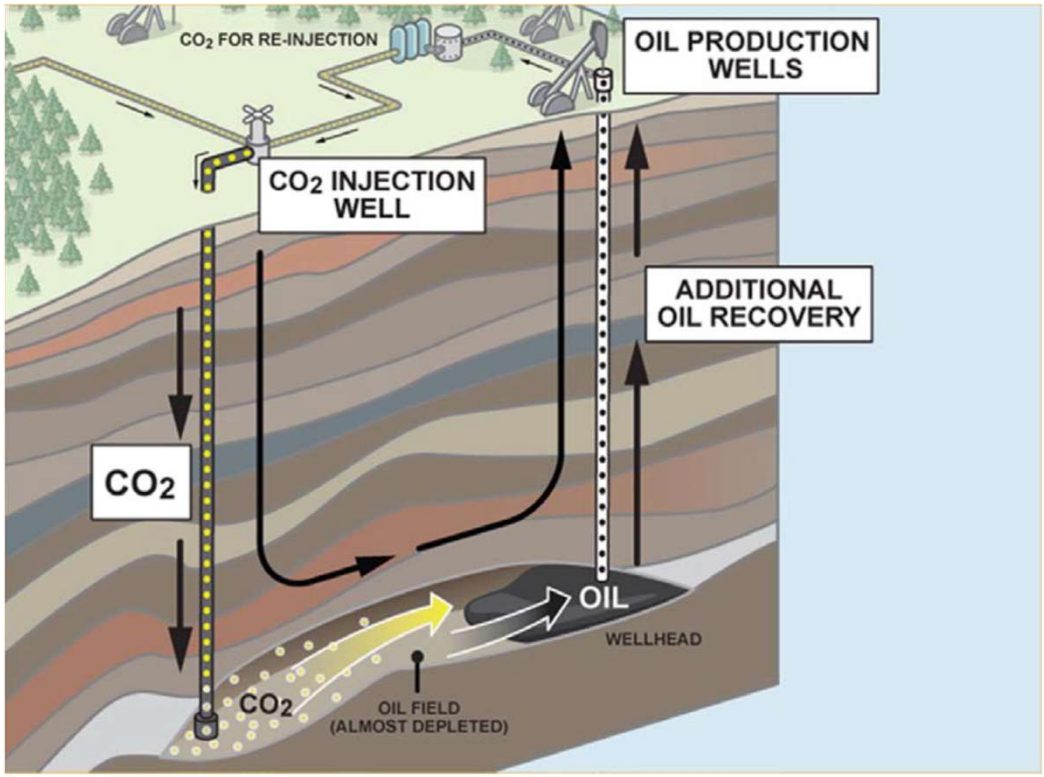


Figure 2. Generalized east-west cross section of Powder River Basin showing a west side basin axis. Black Hills monocline is shown in Cretaceous and Paleozoic rocks on east side of basin.

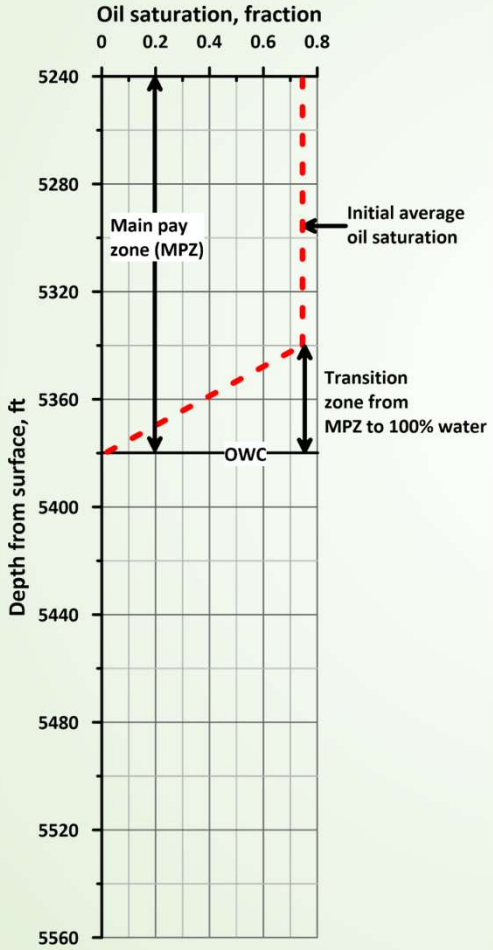
Background: Importance to DOE Program Goals

- CO_2-EOR
  - Squeezes out additional, hard-to-recover oil
  - Permanently stores CO_2 underground
- ROZ CO_2 Storage Project
  - Quantify new and potentially large sequestration opportunities
  - Determine economic viability

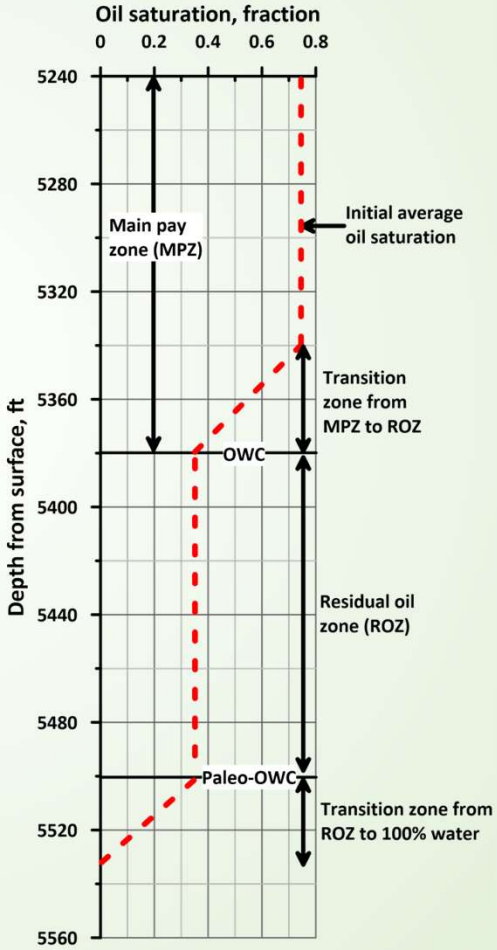


What is a Residual Oil Zone (ROZ)?

Conventional (no ROZ)



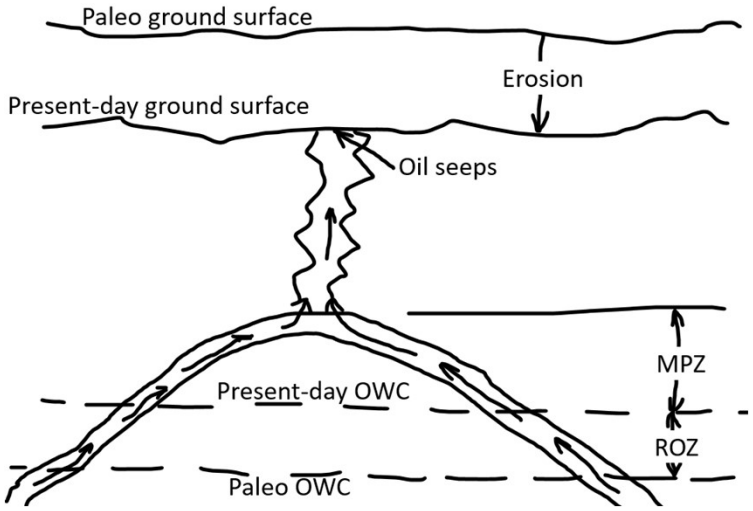
Field with associated ROZ

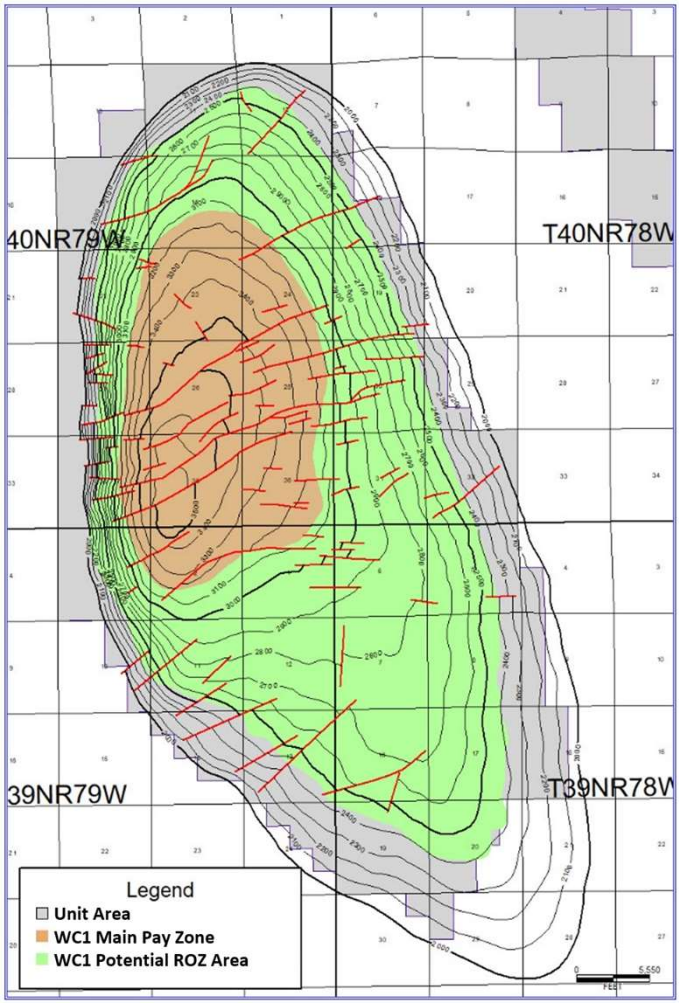


Salt Creek Field – Potentially Extensive ROZ

Conceptualized Formation of Type II ROZ at Salt Creek Field

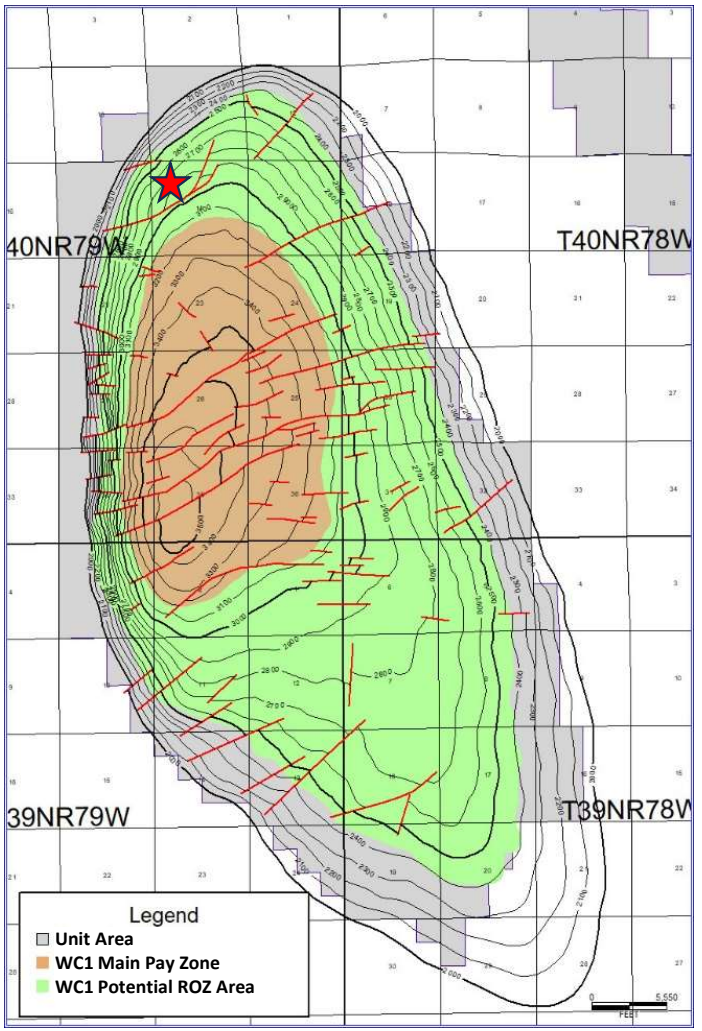
1. Paleo trap formed and charged
2. Loss of overburden due to erosion
3. Reservoir pressure exceeds seal integrity
4. Oil seeps to surface as reservoir pressure equilibrates with new overburden stress and reservoir seal
5. New OWC established at bottom of MPZ
6. ROZ established between new OWC and paleo OWC





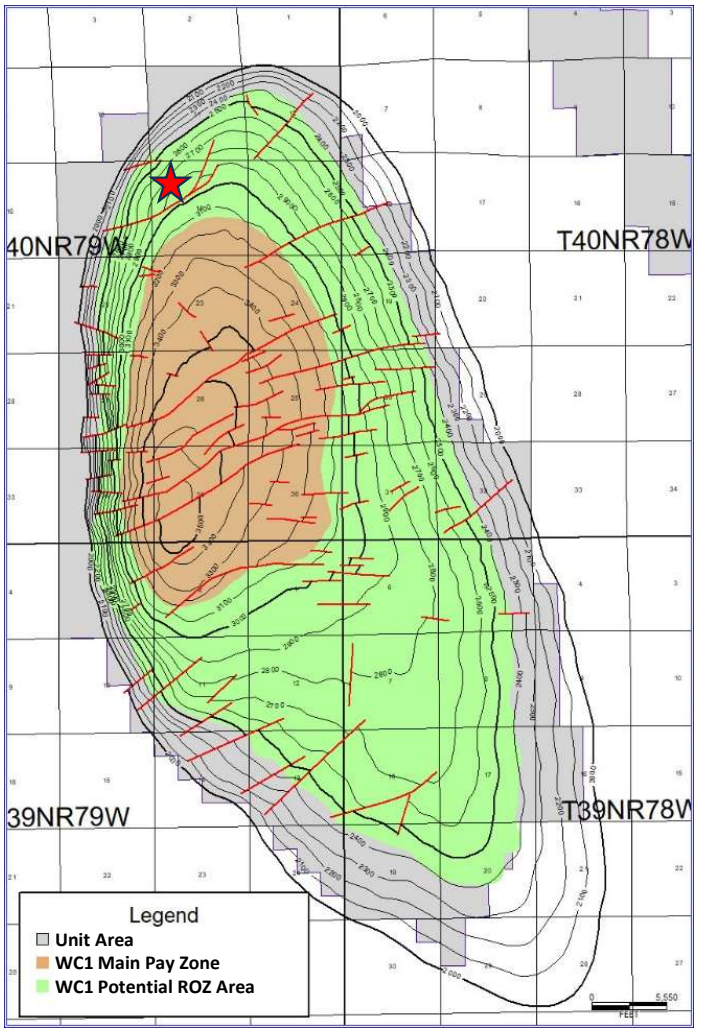
Technical Approach: Establish a Field Laboratory

- The Field Lab consists of
  - Geologic model
  - Reservoir numerical model
  - Physical well (core, logs, and fluids)
- Preliminary geologic model is complete
- Preliminary reservoir model is complete
- Well to be drilled, logged, and cored in early October 2023



Current Project Status: Reservoir Modelling

- Single-well numerical CMG-GEM model
- Reservoir and fluid properties obtained from company-provided, pre-existing data
- ¼ pattern for a 20-acre 5-spot model
- Modeled hypothetical primary, secondary, and CO_2-EOR (water-alternating-gas) with CO_2 storage



Preliminary Modeling Data and Results at Field Lab Site

	Parameter	Value	Units
Inputs	Depth from surface	1570	ft
	Thickness	128	ft
	Permeability	28	mD
	Porosity	0.16	fraction
	Water Saturation	0.64	fraction
	Reservoir Pressure	728	psia
	MMP	1290	psia
	Oil-in-place (OIP)	273	million STB
Results	Recovery factor	0.20	fraction
	Gross CO_2 Injected	0.42	Mt

(Mt = Mega tonnes = million metric tons)

These results will be reevaluated and updated based on analysis of logging, fluid sampling, core analysis, and coreflooding data

Project Status: New Field Operator

Onboarded new Field Operator

- Contango Resources new operator of the Salt Creek Field
- Received commitment letter from Contango in June 2022
- Submitted APD in January 2023
- Expect approval of permit in September 2023
- Plan to drill, core, and log Field Lab well in October 2023

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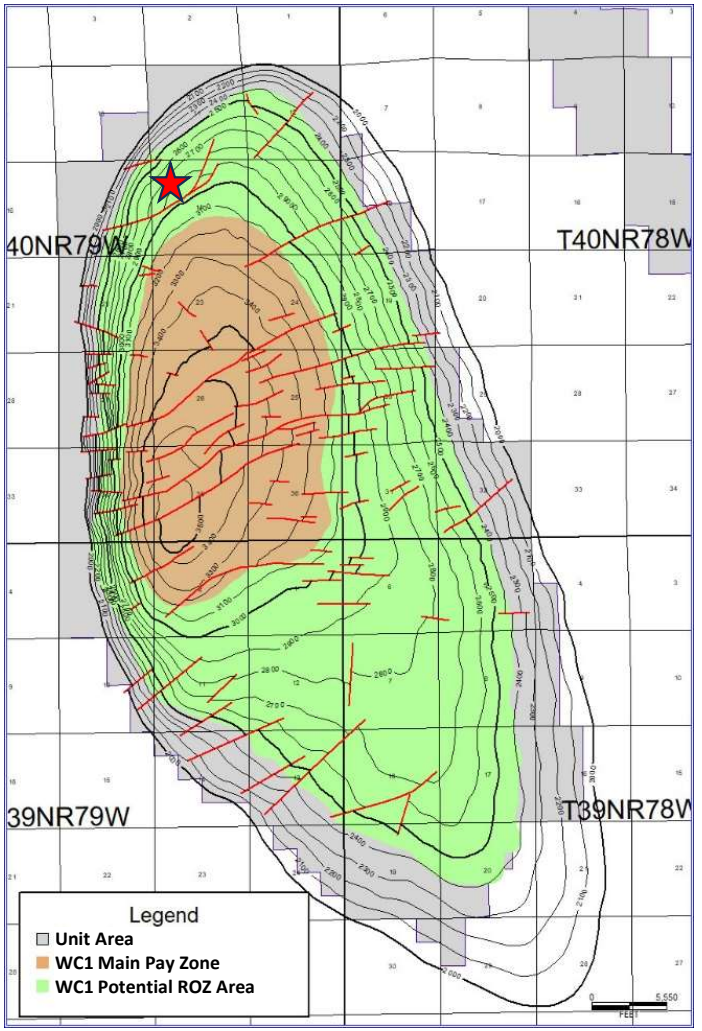
Project Challenges

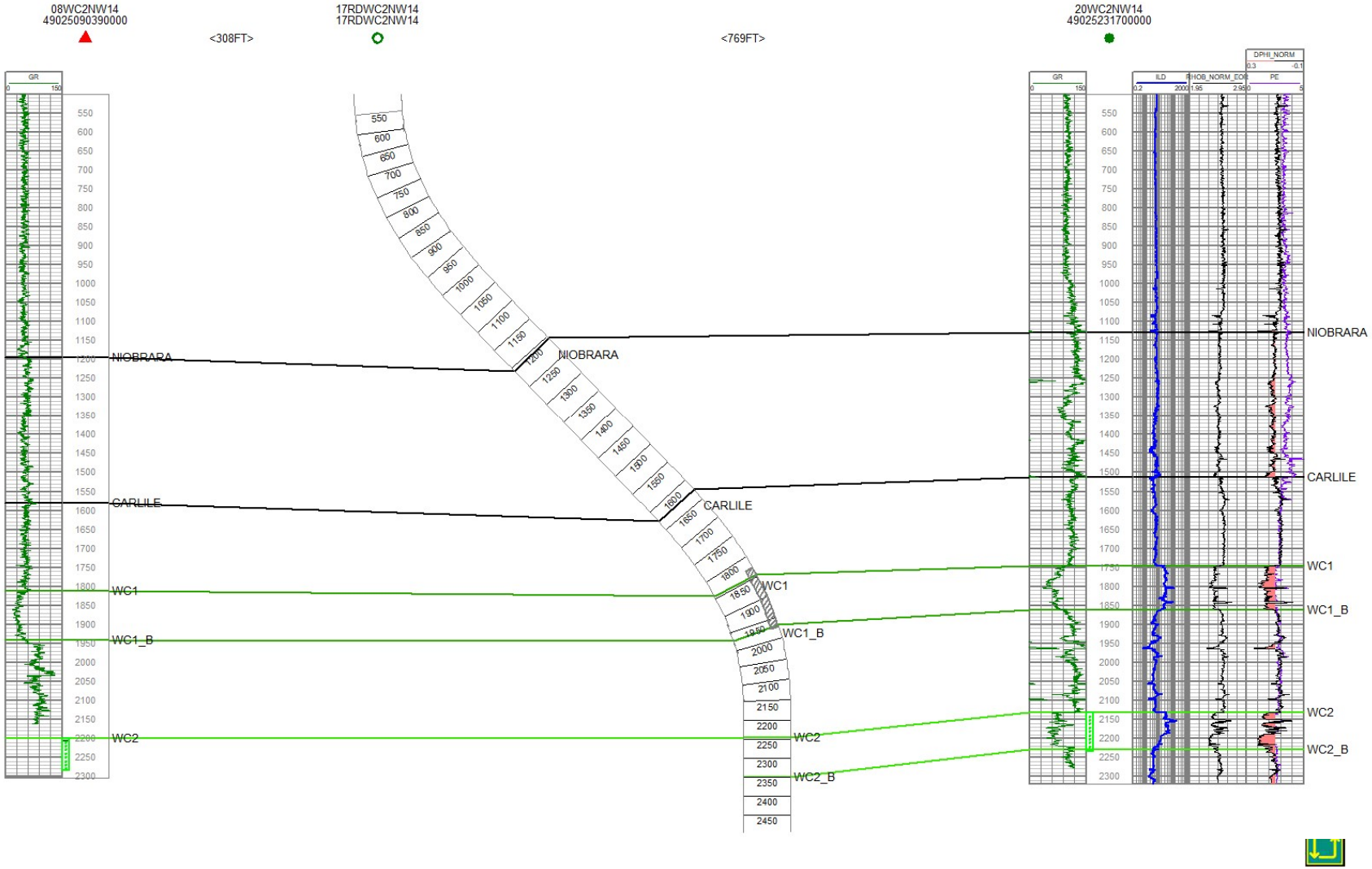
- Timeline: Project is behind original schedule
  - Originally a 2-yr project: Nov 2019 through Sep 2021
  - Change in field ownership
  - Location of Field Lab was an issue
  - Oil price collapse in 2020
  - Three changes in Project Leadership
- Technical: In situ saturations are uncertain
- A huge help: DOE project management



Next Steps for Project

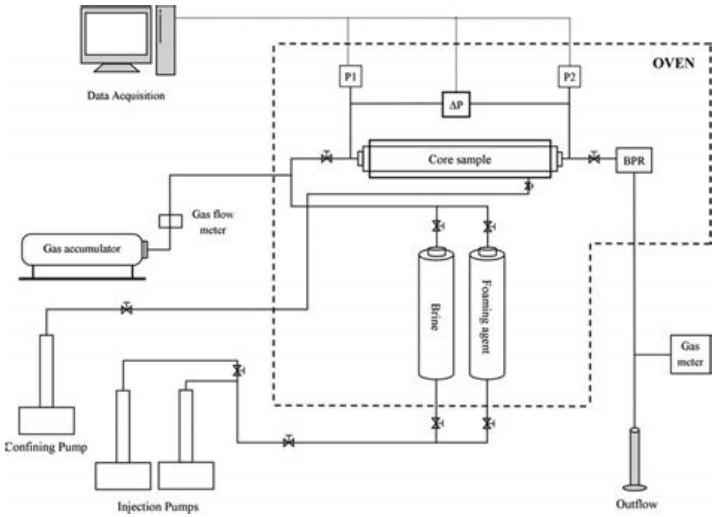
- Drill new well in early-October
  - Mid-September: BLM approval for new well
  - Collect new core
    - 180 ft of 4.5-in.
    - Carlile Shale (seal)
    - WC1
    - bottom shale
  - Log well and sample downhole fluid

Next Steps for Project – Wellbore Crossection



Next Steps for Project

- Describe core, identify facies
- Routine and special core analysis
- Tie core data back to well logs
- Perform laboratory CO_2 core floods
- Build-out geologic model to regional area
- Forecast oil recovery and storage with updated dynamic model



Next Steps After Project Ends

- Salt Creek operator may develop the ROZ for oil recovery and CO_2 storage
- Disseminate results
- Work with operators in Salt Creek trend to assess ROZ potential

Thank You!

Questions?

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Advanced Resources International, Inc.