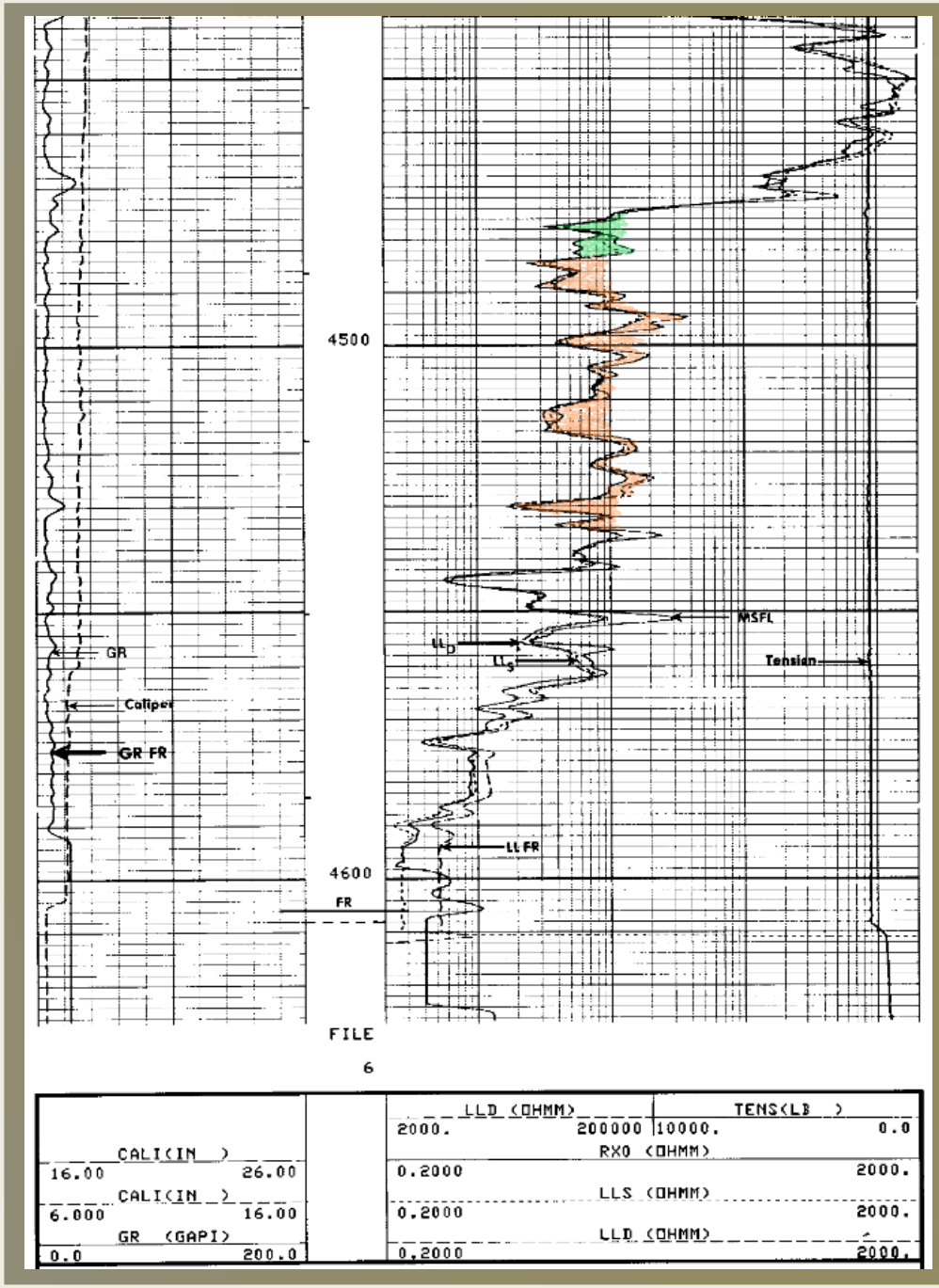
G-058-114: Maximizing Production From Residual Oil Zones in Western North Dakota

COBRA OIL & GAS CORPORATION

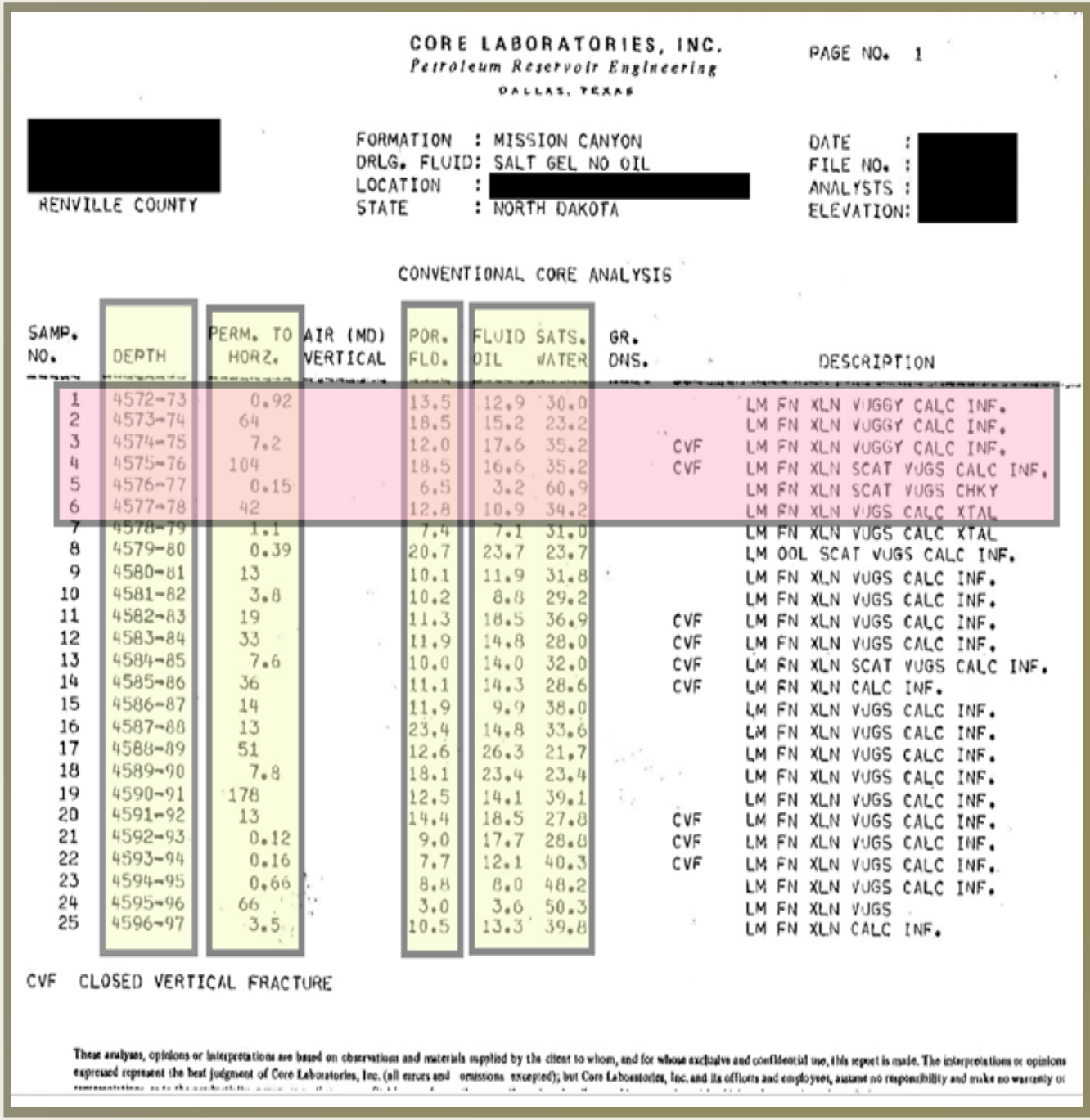
OGRP Update
January 24, 2025
Bismarck, ND

Pre-project Recap

- Cobra purchases assets through bankruptcy in late 2018, begins to return wells to production & commences a strict fluid level & dynamometer program.
- In 2019, Cobra started increasing artificial lift capabilities to draw down back side fluid levels. As back side fluid levels decrease, total oil & water production increase, keeping consistent cuts.
- Cobra uses core data to recomplete multiple wells further down into the section to increase reservoir deliverability. In return further increasing artificial lift and making more total fluid at constant cuts.
- Due to consistent oil & water cuts, with some improved oil cuts, Cobra hypothesized these efforts to be manipulation of a ROZ.



- Standard conventional approach "Pop the Top"
- Cobra Oil & Gas ROZ approach (orange section)
- Rock data, petrophysical data, mudlog data, & production data support a Type II ROZ.



CORE LABORATORIES, INC.
Petroleum Reservoir Engineering
DALLAS, TEXAS

PAGE NO. 1

[redacted]
RENVILLE COUNTY

FORMATION : MISSION CANYON
DRLG. FLUID: SALT GEL NO OIL
LOCATION : [redacted]
STATE : NORTH DAKOTA

DATE :
FILE NO. : [redacted]
ANALYSTS :
ELEVATION:

CONVENTIONAL CORE ANALYSIS

SAMP. NO.	DEPTH	PERM. TO AIR (MD) HOR.	VERTICAL	POR. FLO.	FLUID SATS. OIL	WATER	GR. DNS.	DESCRIPTION
1	4572-73	0.92		13.5	12.9	30.0		LM FN XLN VUGGY CALC INF.
2	4573-74	64		18.5	15.2	23.2		LM FN XLN VUGGY CALC INF.
3	4574-75	7.2		12.0	17.6	35.2	CVF	LM FN XLN VUGGY CALC INF.
4	4575-76	104		18.5	16.6	35.2	CVF	LM FN XLN SCAT VUGS CALC INF.
5	4576-77	0.15		6.5	3.2	60.9		LM FN XLN SCAT VUGS CHKY
6	4577-78	42		12.8	10.9	34.2		LM FN XLN VUGS CALC XTAL
7	4578-79	1.1		7.4	7.1	31.0		LM FN XLN VUGS CALC XTAL
8	4579-80	0.39		20.7	23.7	23.7		LM OOL SCAT VUGS CALC INF.
9	4580-81	13		10.1	11.9	31.8		LM FN XLN VUGS CALC INF.
10	4581-82	3.8		10.2	8.8	29.2		LM FN XLN VUGS CALC INF.
11	4582-83	19		11.3	18.5	36.9	CVF	LM FN XLN VUGS CALC INF.
12	4583-84	33		11.9	14.8	28.0	CVF	LM FN XLN VUGS CALC INF.
13	4584-85	7.6		10.0	14.0	32.0	CVF	LM FN XLN SCAT VUGS CALC INF.
14	4585-86	36		11.1	14.3	28.6	CVF	LM FN XLN CALC INF.
15	4586-87	14		11.9	9.9	38.0		LM FN XLN VUGS CALC INF.
16	4587-88	13		23.4	14.8	33.6		LM FN XLN VUGS CALC INF.
17	4588-89	51		12.6	26.3	21.7		LM FN XLN VUGS CALC INF.
18	4589-90	7.8		18.1	23.4	23.4		LM FN XLN VUGS CALC INF.
19	4590-91	178		12.5	14.1	39.1		LM FN XLN VUGS CALC INF.
20	4591-92	13		14.4	18.5	27.8	CVF	LM FN XLN VUGS CALC INF.
21	4592-93	0.12		9.0	17.7	28.8	CVF	LM FN XLN VUGS CALC INF.
22	4593-94	0.16		7.7	12.1	40.3	CVF	LM FN XLN VUGS CALC INF.
23	4594-95	0.66		8.8	8.0	48.2		LM FN XLN VUGS CALC INF.
24	4595-96	66		3.0	3.6	50.3		LM FN XLN VUGS
25	4596-97	3.5		10.5	13.3	39.8		LM FN XLN CALC INF.

CVF CLOSED VERTICAL FRACTURE

These analyses, opinions or interpretations are based on observations and materials supplied by the client to whom, and for whose exclusive and confidential use, this report is made. The interpretations or opinions expressed represent the best judgment of Core Laboratories, Inc. (all errors and omissions excepted); but Core Laboratories, Inc. and its officers and employees, assume no responsibility and make no warranty or

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ANALYSTS :
ELEVATION: [redacted]

CONVENTIONAL CORE ANALYSIS

SAMP. NO.	DEPTH	PERM. TO AIR (MD) HORZ.	VERTICAL	POR. FLD.	FLUID SATS. OIL	WATER	GR. DNS.	DESCRIPTION
26	4597-98	20		14.3	8.0	29.5		LM FN XLN CALC INF.
27	4598-99	38		14.6	9.3	42.6		LM FN XLN CALC INF.
28	4599 -0	2.6		13.3	11.6	26.0	CVF	LM FN XLN VUGS CALC INF.
29	4600 -1	200		15.2	11.2	31.0	CVF	LM FN XLN SCAT VUGS CALC INF.
30	4601 -2	11		11.5	15.2	28.8	CVF	LM FN XLN SCAT VUGS CALC INF.
31	4602 -3	157		21.7	14.0	29.7	CVF	LM FN XLN OOL CALC INF.
32	4603 -4	250		18.3	17.2	27.4	CVF	LM FN XLN VUGS CALC INF.
33	4604 -5	31		17.9	12.8	28.8	CVF	LM FN XLN OOL CALC INF.
34	4605 -6	314		15.8	14.9	27.5	CVF	LM FN XLN OOL CALC INF
35	4606 -7	61		18.1	15.5	35.2	CVF	LM FN XLN CALC INF.
36	4607 -8	93		15.2	17.4	32.4		LM FN XLN CALC INF.
	4608-4612							NO ANALYSIS LS
37	4612-13	24		10.6	13.1	26.1	CVF	LM FN XLN CALC INF.
38	4613-14	6.5		7.0	3.0	62.7	CVF	LM V/FN XLN CALC INF.
39	4614-15	113		9.1	2.3	51.9	CVF	LM V/FN XLN CALC INF.
40	4615-16	41		8.9	1.1	43.2	CVF	LM V/FN XLN CALC INF.
	4616-4623							NO ANALYSIS LS
41	4623-24	0.03		6.7	7.7	33.8	CVF	LM V/FN XLN CALC INF.
42	4624-25	2.8		10.9	16.3	29.0	CVF	LM V/FN XLN SUC CALC INF.

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Project Summary

- Project Intent: Investigate methods and strategies to maximize oil recovery within Madison oil fields in western North Dakota

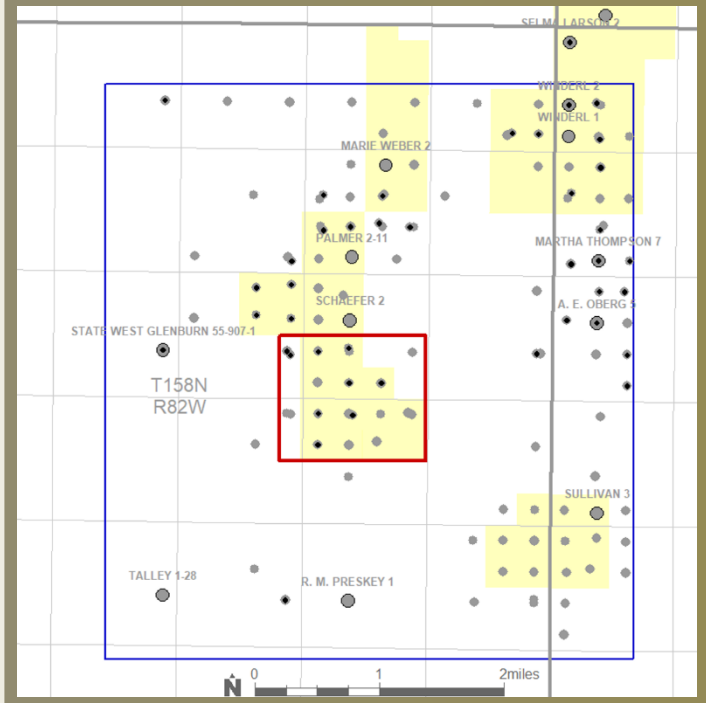
- Hypothesis: Using new and existing reservoir characterization and laboratory analytical data coupled with state-of-the-art static and dynamic computer modeling to design and implement pilot-scale field injection tests, optimized production strategies for **residual oil zones (ROZs)** of the Madison Group's Mission Canyon Formation can be developed.

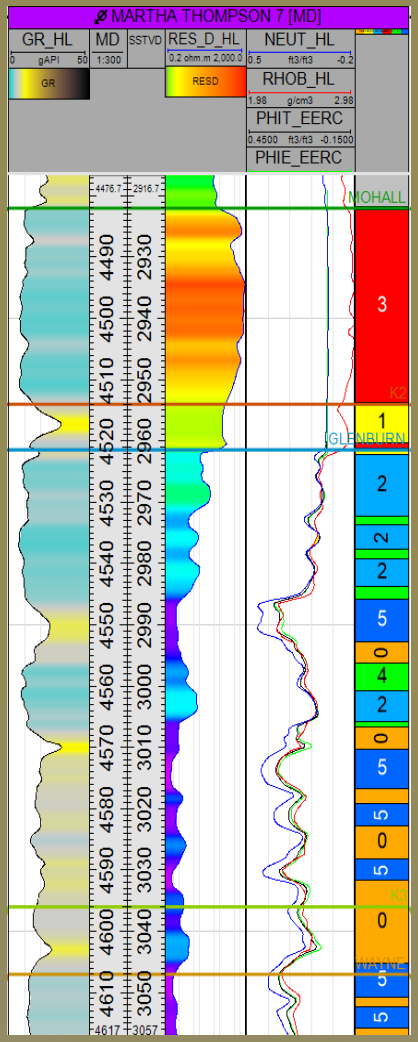
- Draft Findings:
  - ROZ is not present in Glenburn Field; production is from transition zone oil with some wells experiencing water coning stranding oil.
  - Oil production can be maximized through the management of water coning, increased cumulative fluid flow, and pressure maintenance.

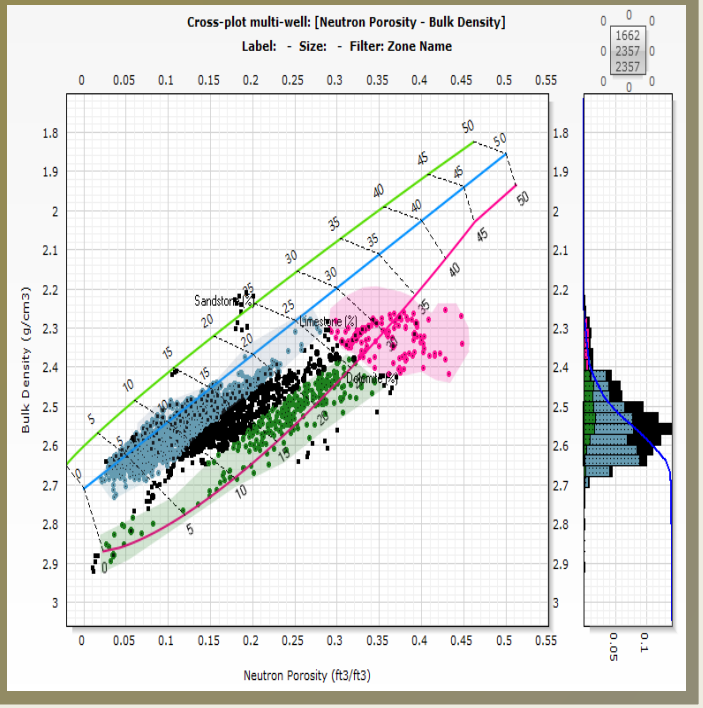
Task Summary

Project Task	Details	Status
Task 1: Data Assembly	Data Audit	Complete
	Core Workshop	
Task 2: Reservoir Characterization	Stratigraphy	Complete
	Petrophysics	
	Geologic Model	
	Uncertainty Analysis	
Task 3: Numeric Simulation	History Matching	Complete
	Optimization Scenarios	In Progress
	Sensitivity Analysis	In Progress
Task 4 – Data Collection and Field Testing	Field Activities	In Progress
	Lab: Porosity and Permeability	Complete
	Lab: Relative Permeability	In Progress

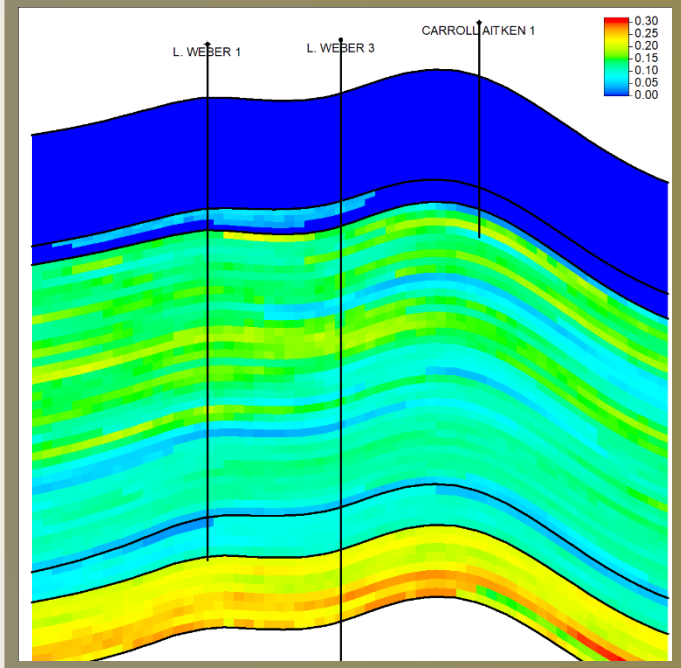
Preliminary Results



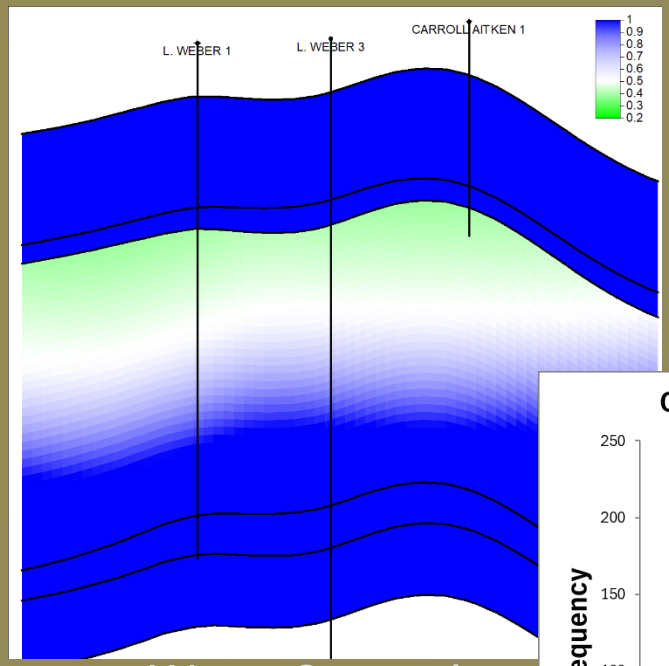




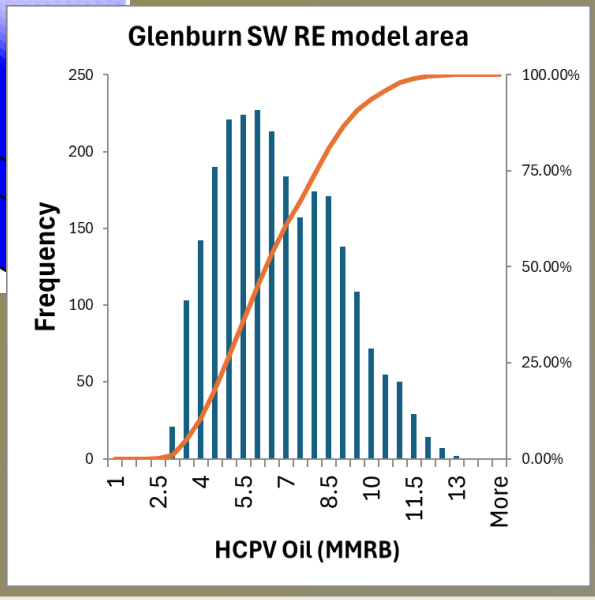
Reservoir Characterization



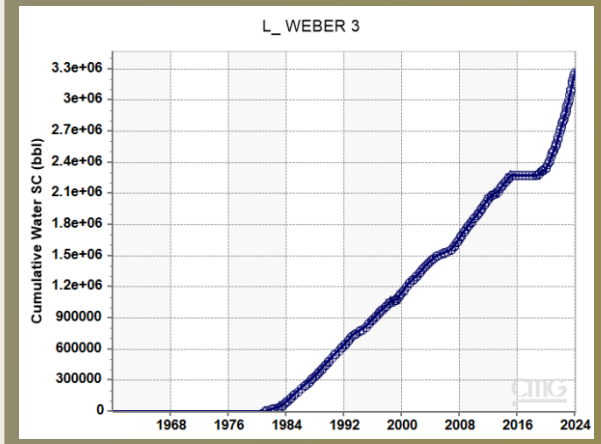
Porosity

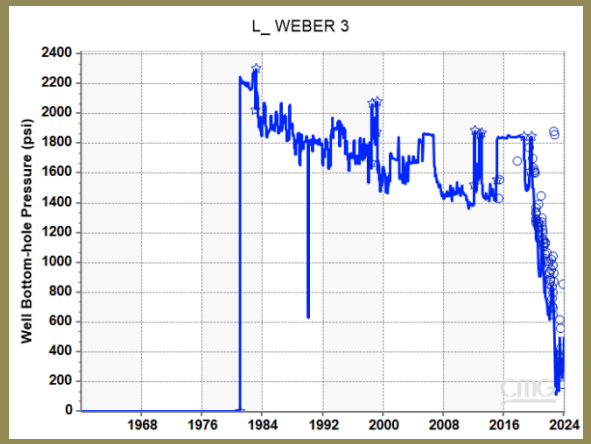


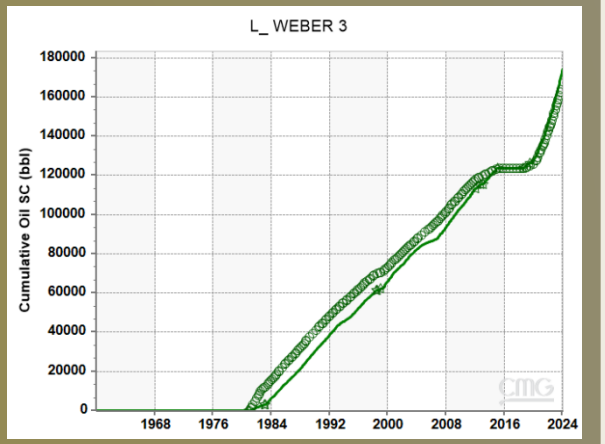
Water Saturation

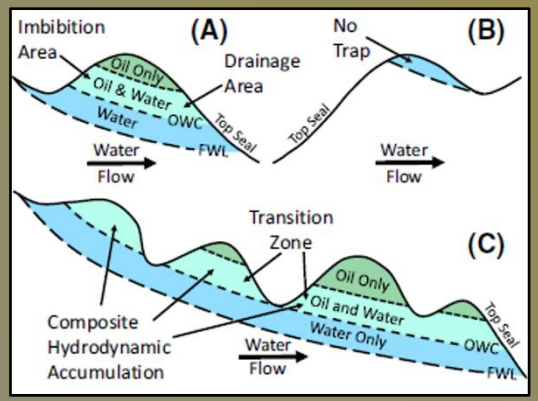


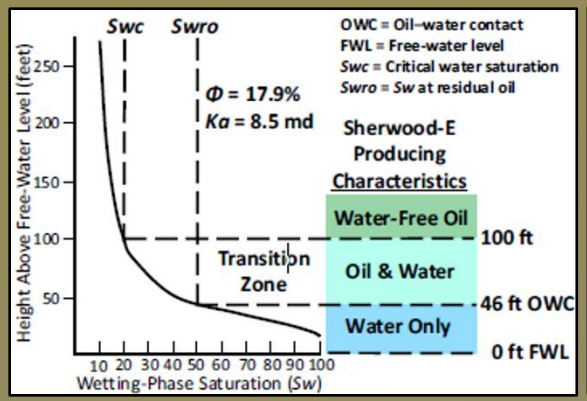
Numeric Simulation

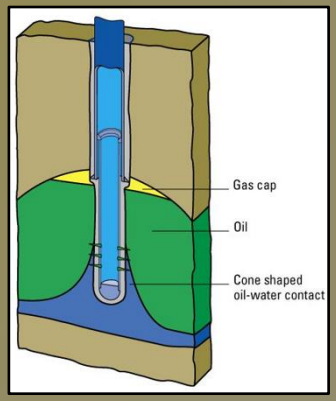












Petty, D.M., 2024. Hydrocarbon trapping in hydrodynamic salinity gradients: Williston Basin case studies. *AAPG Bulletin*, *108*(2), pp.351-377.

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