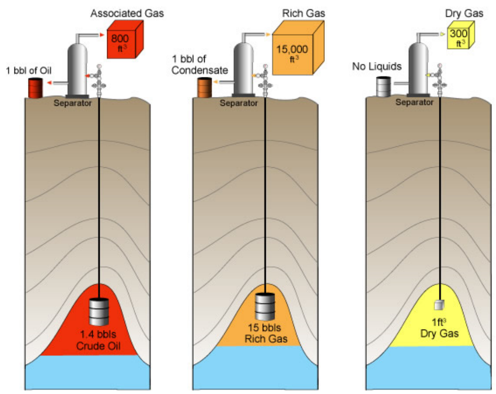
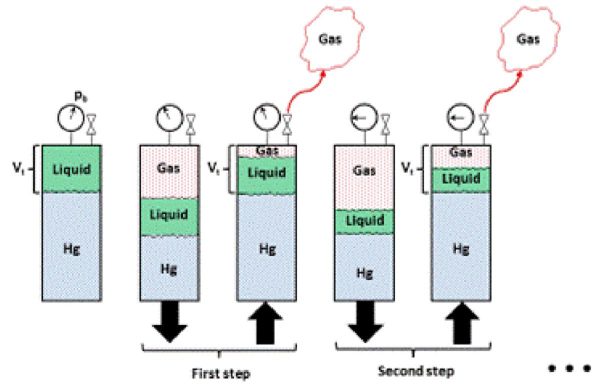
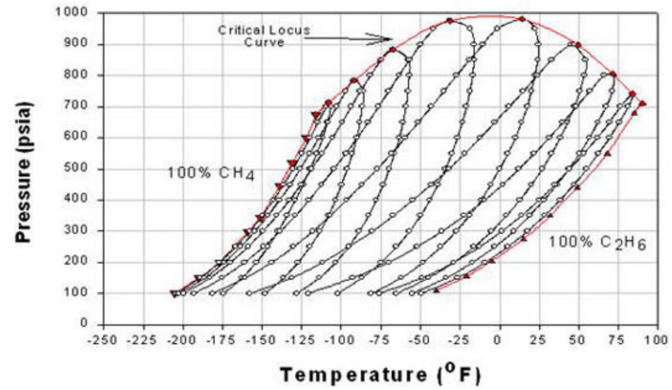
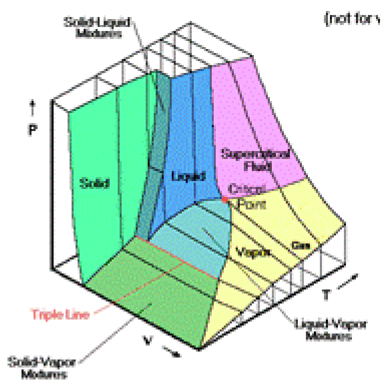


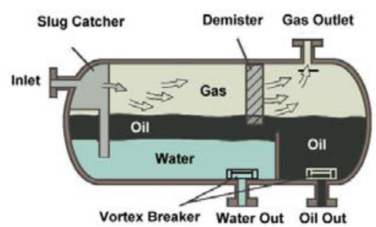


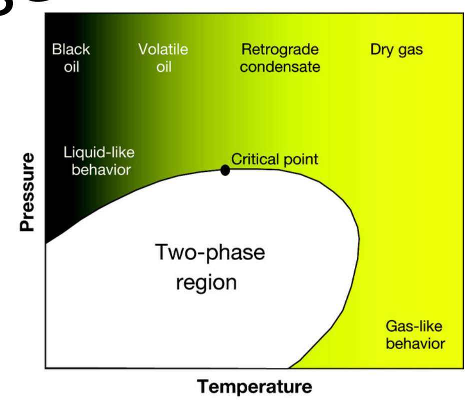


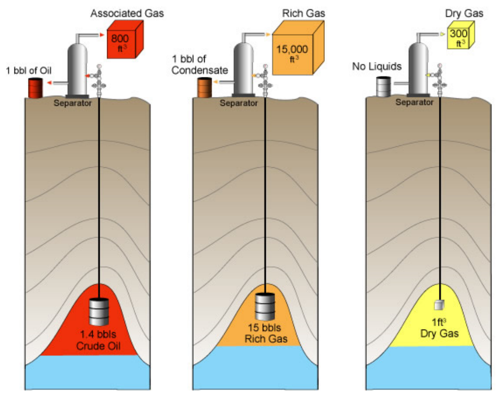
Opportunities for CO2 EOR in Unconventional Reservoirs

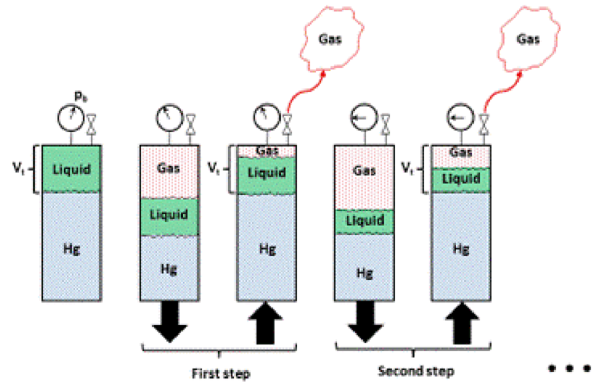
Learning from the Permian;
Developing new knowledge

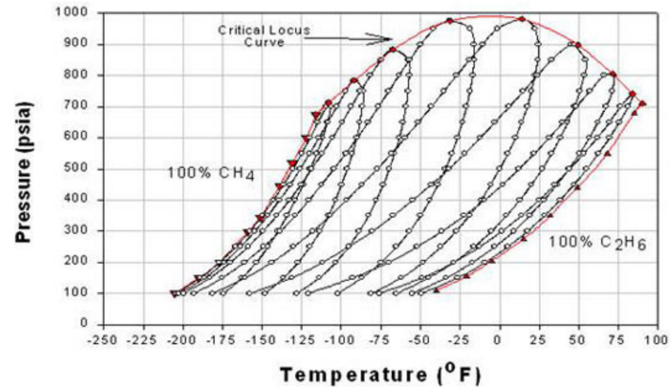






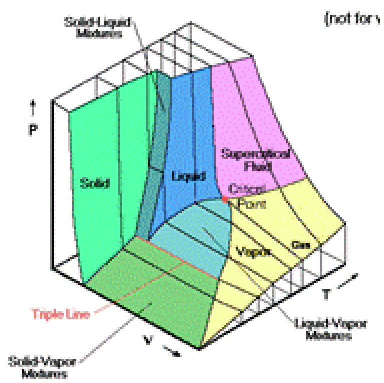


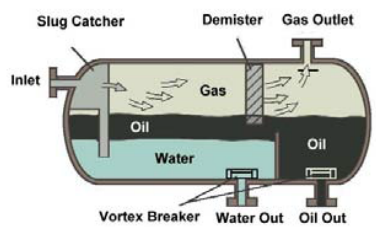


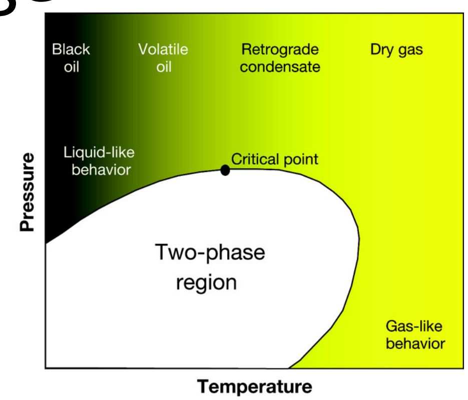


Opportunities for CO2 EOR in Shale Plays

Learning from the Permian; Developing new knowledge







Outline

01

Learning from CO_2 use in the Permian Basin

- Rules of thumb: what are they based on?
- Historic and current CO_2 use in PB

02

Developing new knowledge for CO_2 use in the Eagle Ford shale

- Location
- Current gas injection projects
- Is there a potential for CO_2?

03

CO_2 potential in other shale plays?

Acknowledgements

material for this presentation came from:

- George Grinestaff, Shale IOR
- Mahendra K. Verma, USGS Report 2015-1071
- NETL (US DOE), “Carbon Dioxide Enhanced Oil Recovery”, 2010
- US EIA website
- TRRC website
- UH professors Michael Craig, Miguel Saldana

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

- Methods to add energy to the reservoir **<u>or</u>** change the character of the contained oil (including by steam injection) became more generally known ***as EOR techniques***
- Widespread application of CO2 injection has occurred in the Permian Basin and in New Mexico:
  – Both areas have large, naturally-occurring sources of CO2 nearby, as well as large, mature waterflood operations

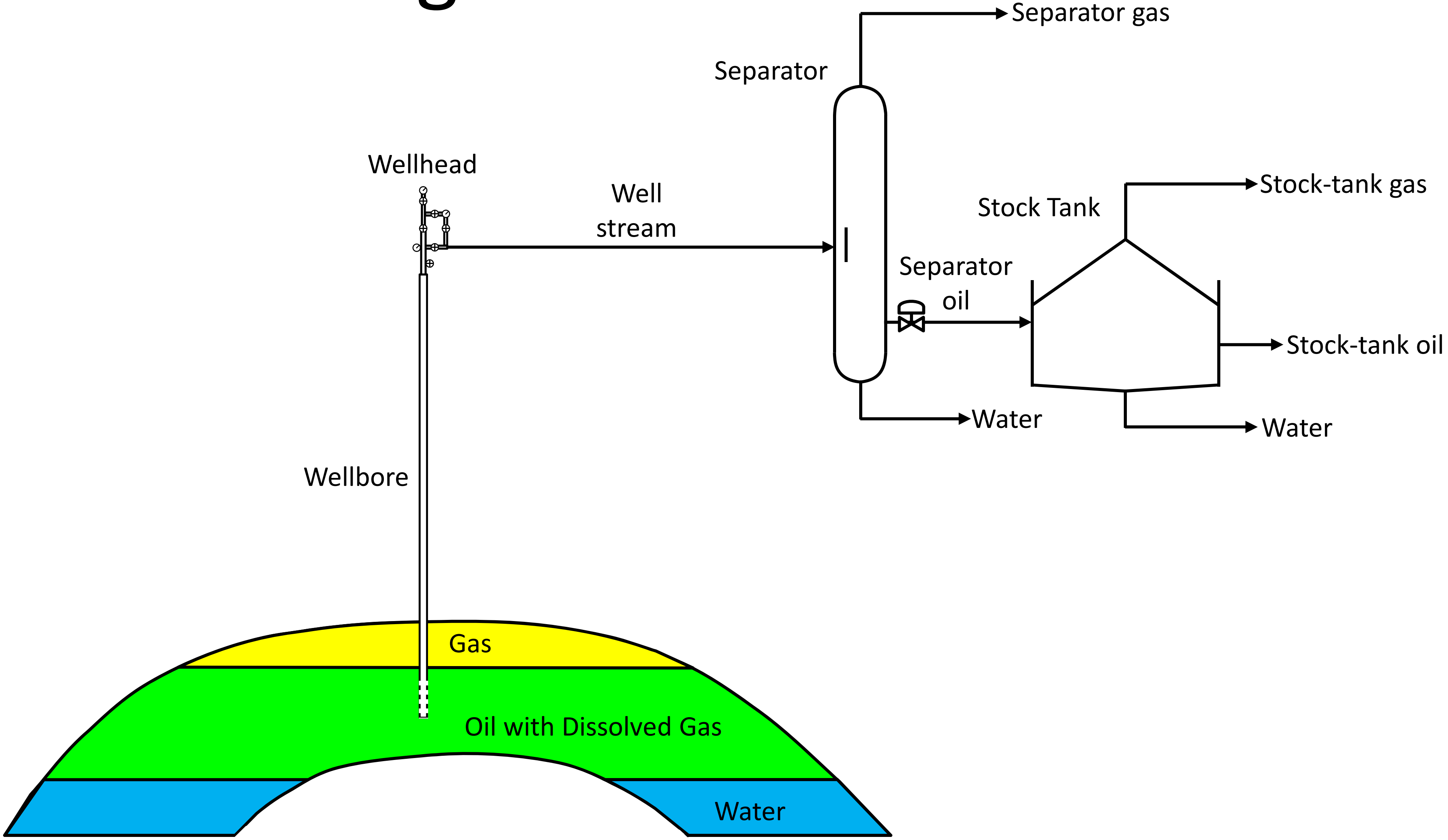
Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

Although it is a gas, in contact with oil at high pressures (over 2,500psi), CO_2 forms a miscible substance

Below the minimum miscibility pressure (MMP), CO_2 and oil will no longer be miscible. As the oil density increases (as the light hydrocarbon fraction decreases), the minimum pressure needed to attain oil/CO_2 miscibility increases. For this reason, oil field operators must consider the pressure of a depleted oil reservoir when evaluating its suitability for CO_2 enhanced oil recovery. Low pressured reservoirs may need to be re-pressurized by injecting water.

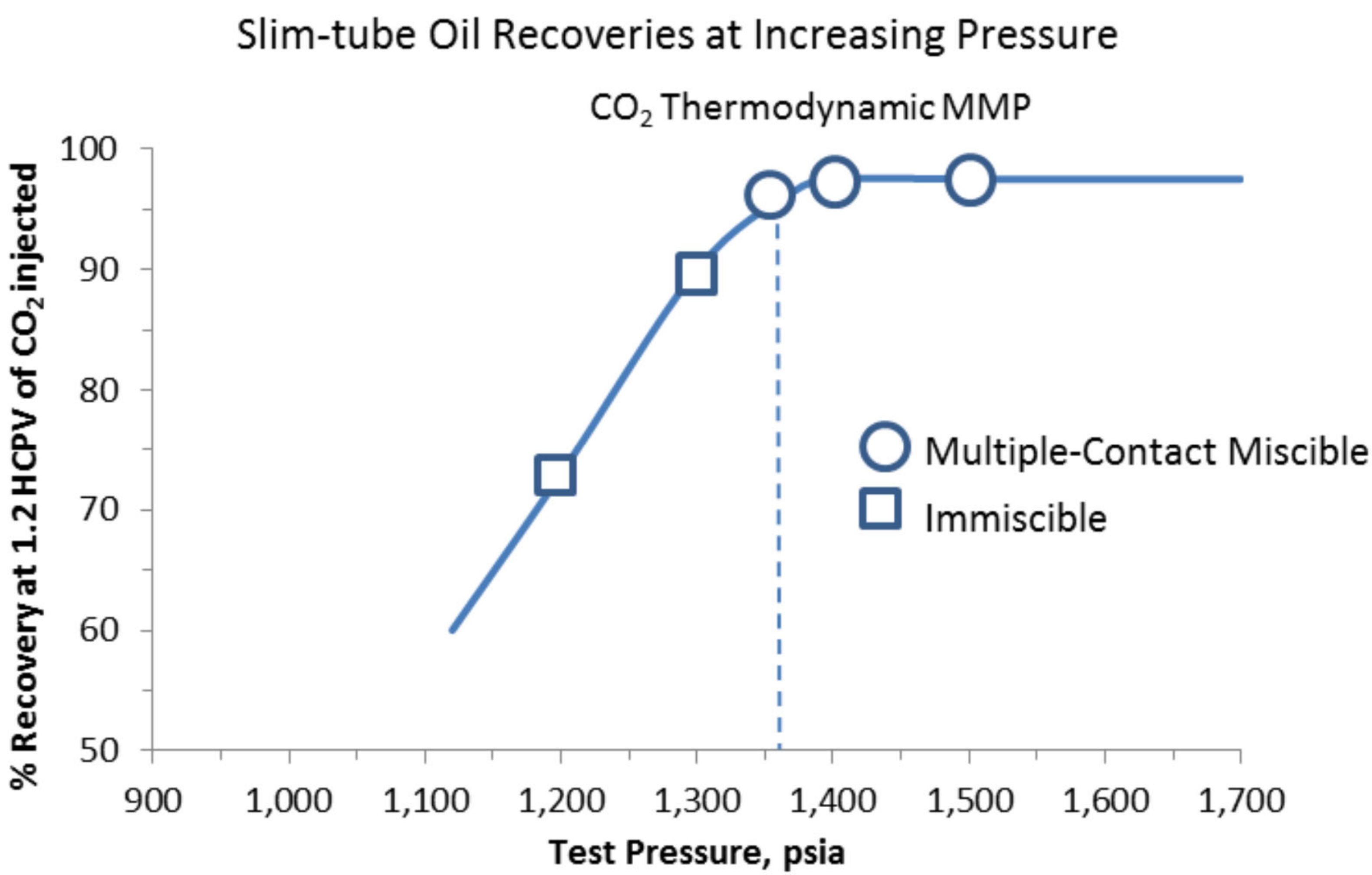
Flow Diagram of Petroleum Fluids



INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

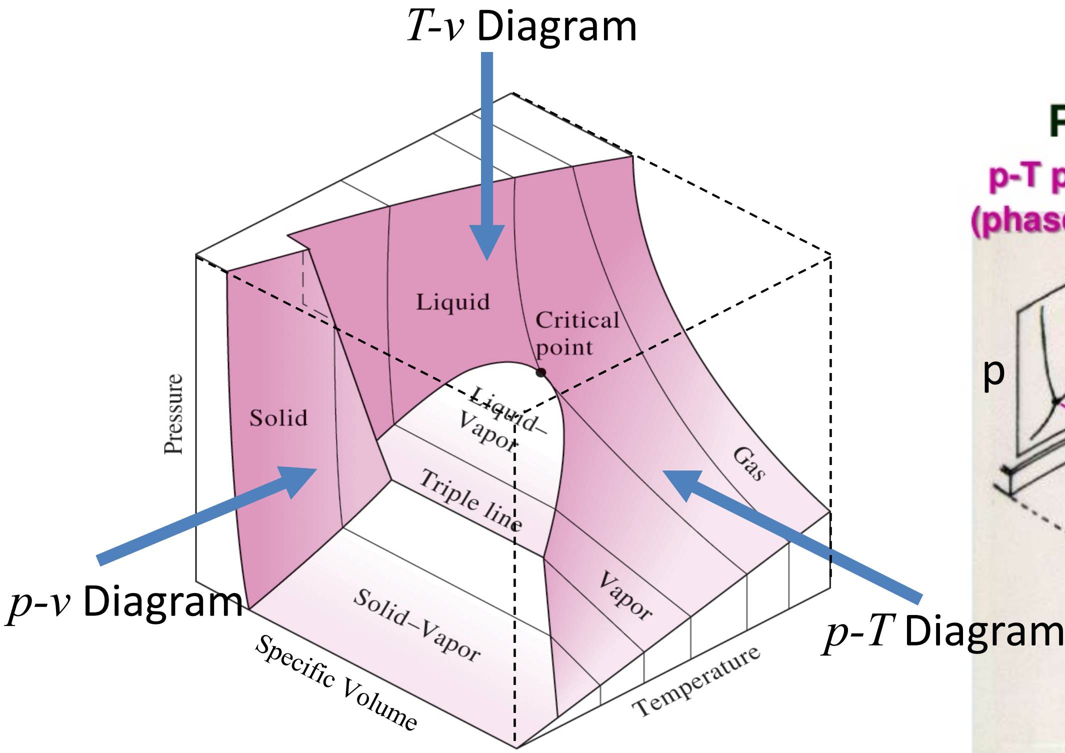
MMP from Slimtube testing

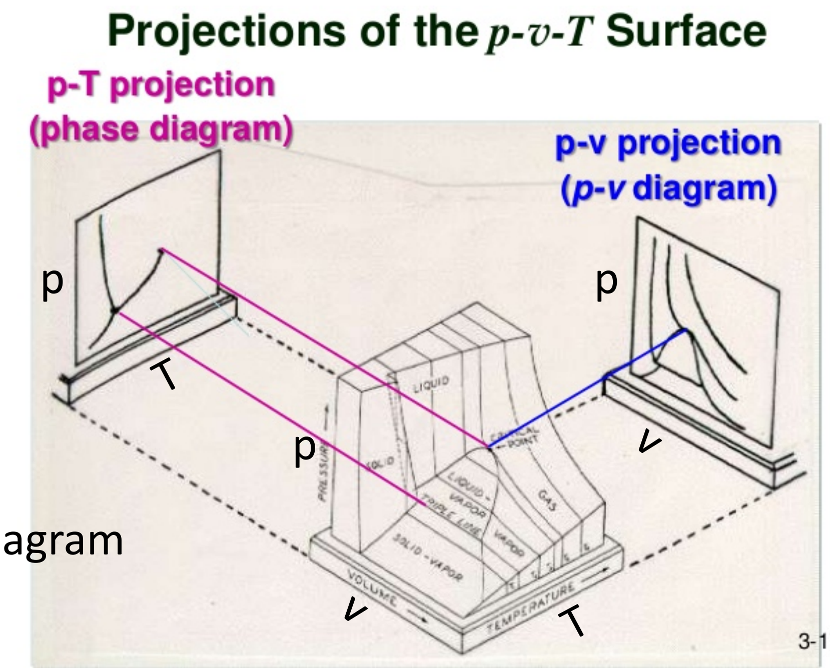


INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

pvT Surface for Water





ρ = density

v = specific volume

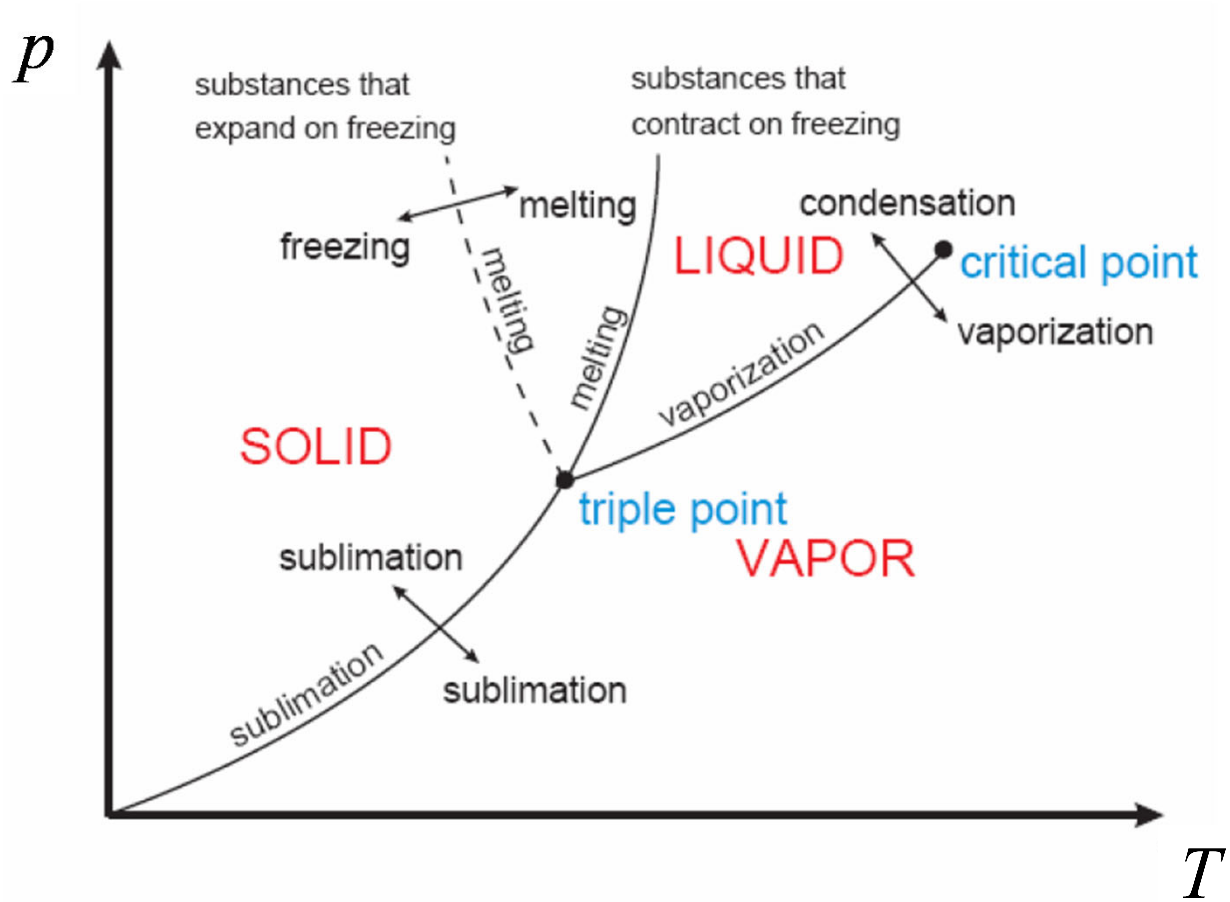
$$\rho = \left[\frac{Mass}{Volume}\right] \qquad v = \frac{1}{\rho} \qquad v = \left[\frac{Volume}{Mass}\right]$$

INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

p-T Phase Diagram for a Pure Component Substance

A substance that has a fixed chemical composition throughout is called a pure substance



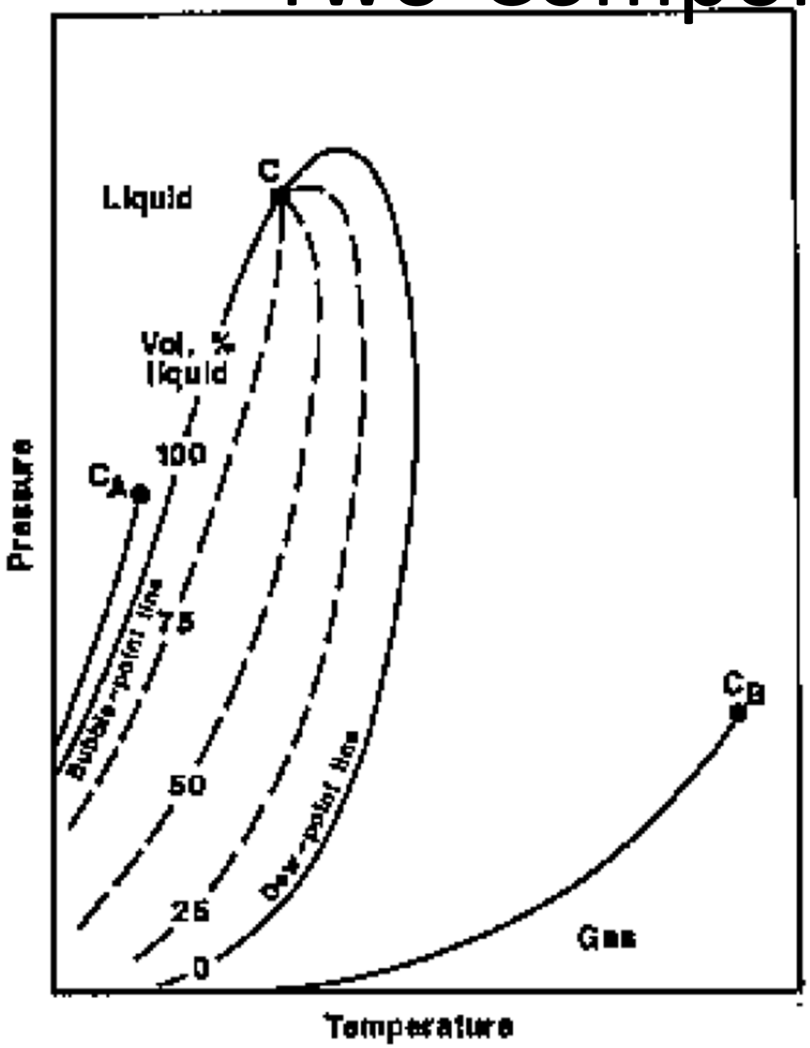
Phase: A distinct molecular arrangement that is homogenous throughout and separated from others by boundary surfaces.

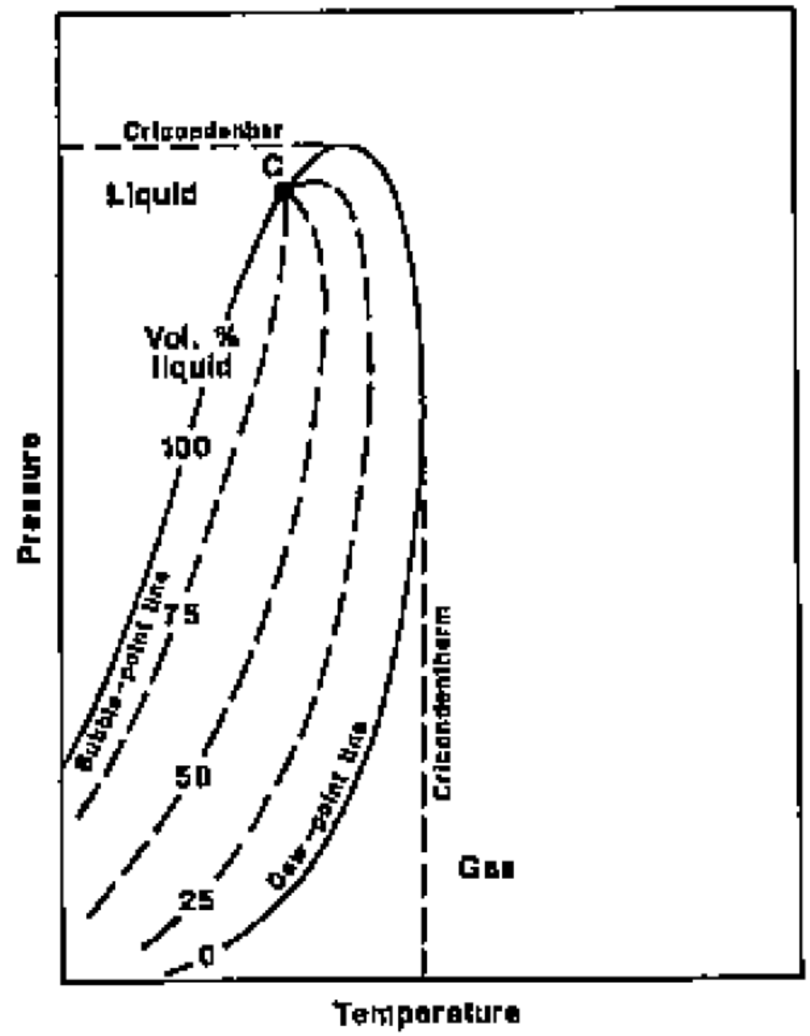
Solid
Liquid
Gas (Vapor)

INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

p-T Phase Diagram for a Two-Component Substance



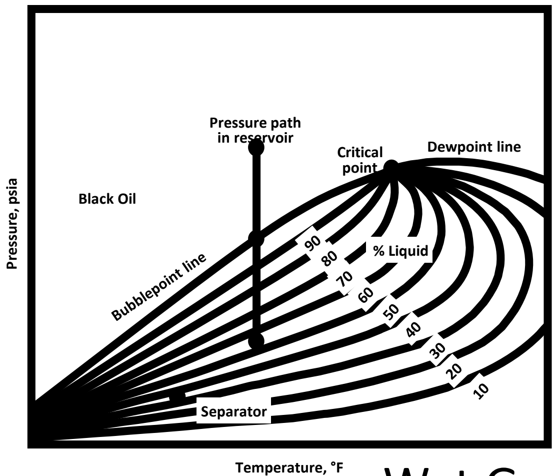


INFORMATION BOX

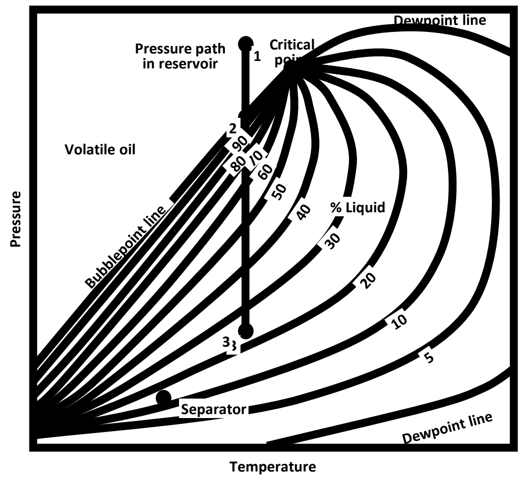
- PVT relationship modeled with an equation of state (EOS)

Phase Diagram for the Five Types of Reservoir Fluids

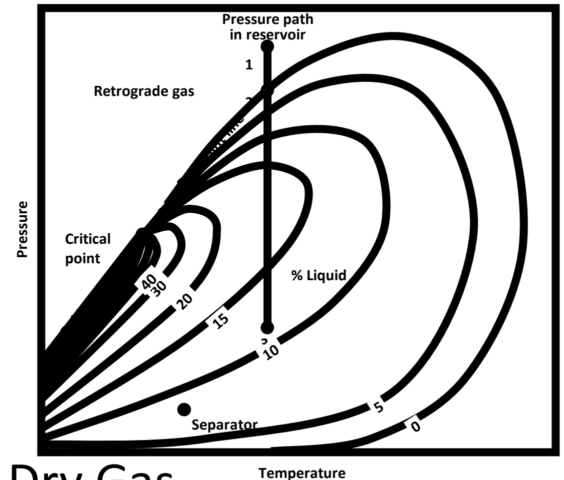
Black Oil



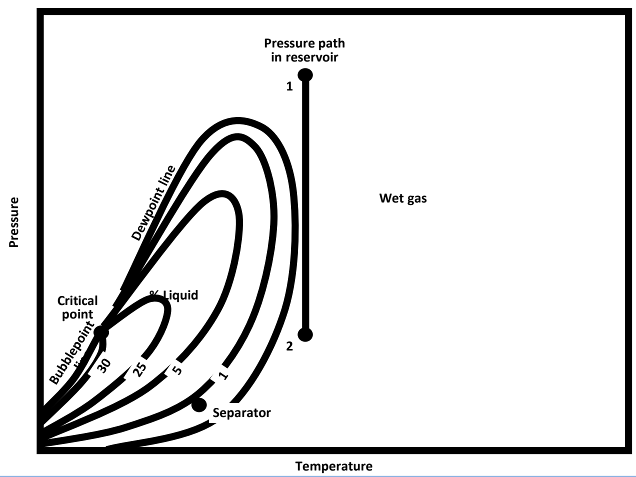
Volatile Oil



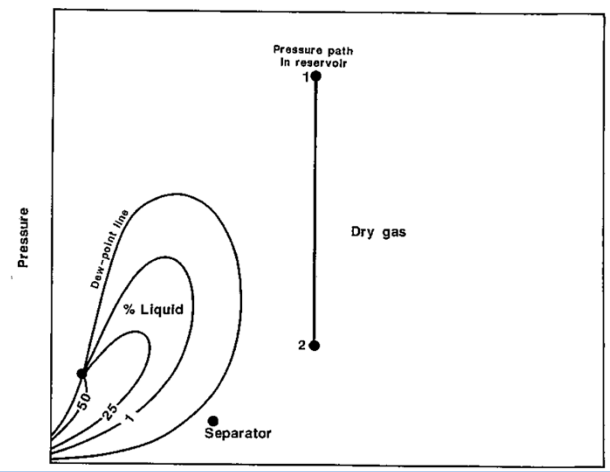
Retrograde Gas



Wet Gas



Dry Gas



INFORMATION BOX

- The five types of Reservoir Fluids

Example Compositions of Reservoir Fluids (mol%)

Component	Black Oil	Volatile Oil	Retrograde Gas	Wet Gas	Dry Gas
C1	56.9	66.7	72.7	88.7	96.37
C2	5.3	9.0	10.0	6.0	3.00
C3	3.8	6.0	6.0	3.0	0.40
i-C4	0.8	0.8	1.0	0.5	0.07
nC4	1.2	2.5	1.5	0.8	0.10
i-C5	0.4	0.8	0.8	0.3	0.02
n-C5	0.4	1.2	1.0	0.3	0.02
C6	1.0	2.0	2.0	0.2	0.02
C7+	30.2	11.0	5.0	0.2	0.00

plus inorganics: N_2, CO_2, H_2S, H_2O

INFORMATION BOX

- The five types of Reservoir Fluids

Classification of Reservoir Fluids

- The behavior of the reservoir fluids during production is determined by
  - Composition of the reservoir fluids
  - Shape and location of the p-T phase diagram
  - Reservoir conditions relative to the critical point on the p-T phase diagram
- In naturally-occurring petroleum fluids, the critical point normally appears to the left of the top of the phase envelope.
  - Liquid and gas can co-exist at p and T higher than the critical point

INFORMATION BOX

- The five types of Reservoir Fluids

The Five Reservoir Fluids

1. ________
2. ________
3. ________
4. ________
5. ________

INFORMATION BOX

- The five types of Reservoir Fluids

Ternary Diagrams

Constant P and T

P (A,B,C)

Point 1: (0,1,0)

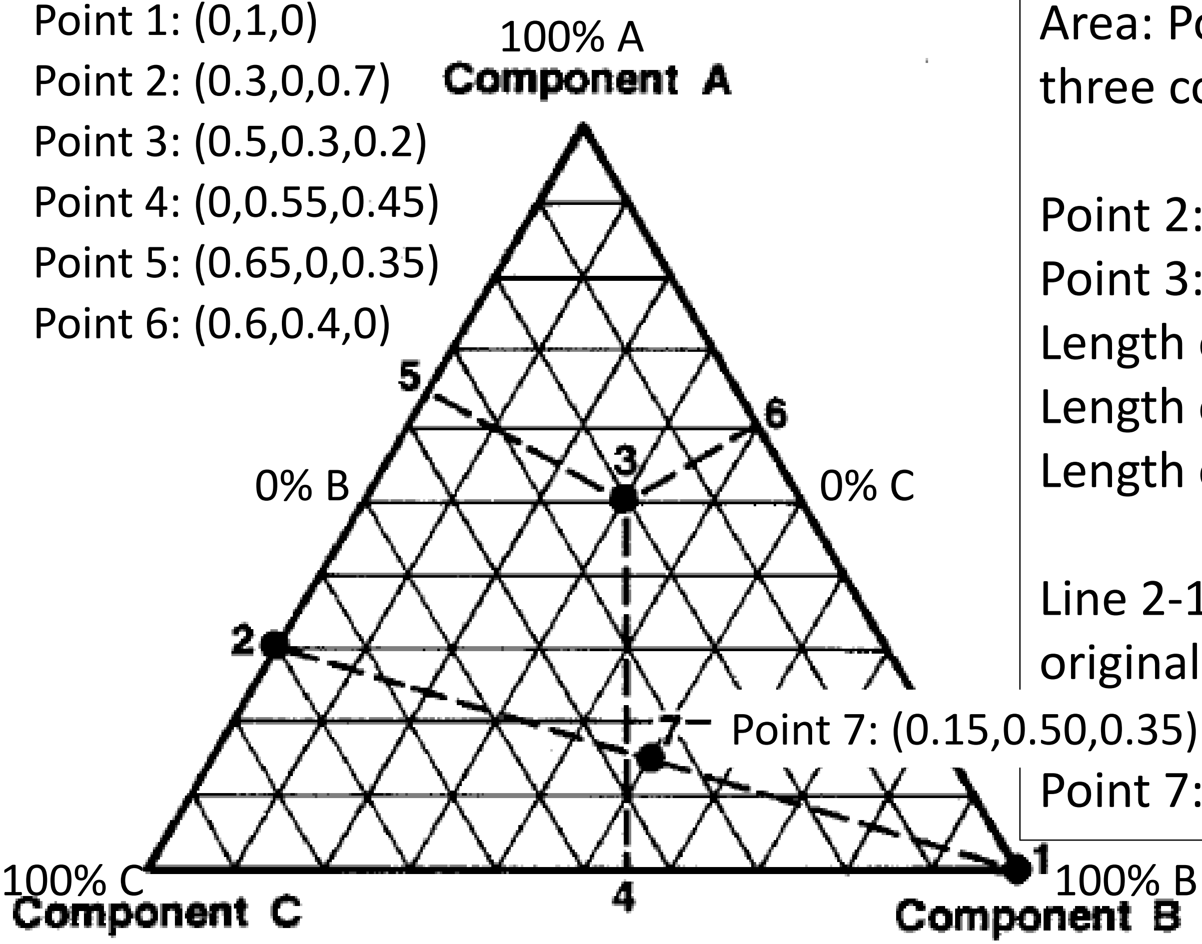
Point 2: (0.3,0,0.7)

Point 3: (0.5,0.3,0.2)

Point 4: (0,0.55,0.45)

Point 5: (0.65,0,0.35)

Point 6: (0.6,0.4,0)



Point 7: (0.15,0.50,0.35)

Vertices: Pure components

Sides: Mixture of 2 components

Area: Possible combinations of the three components A, B, C

Point 2: Mixture of A and C

Point 3: Mixture of A, B, C

Length of 3-4: Composition of A

Length of 3-5: Composition of B

Length of 3-6: Composition of C

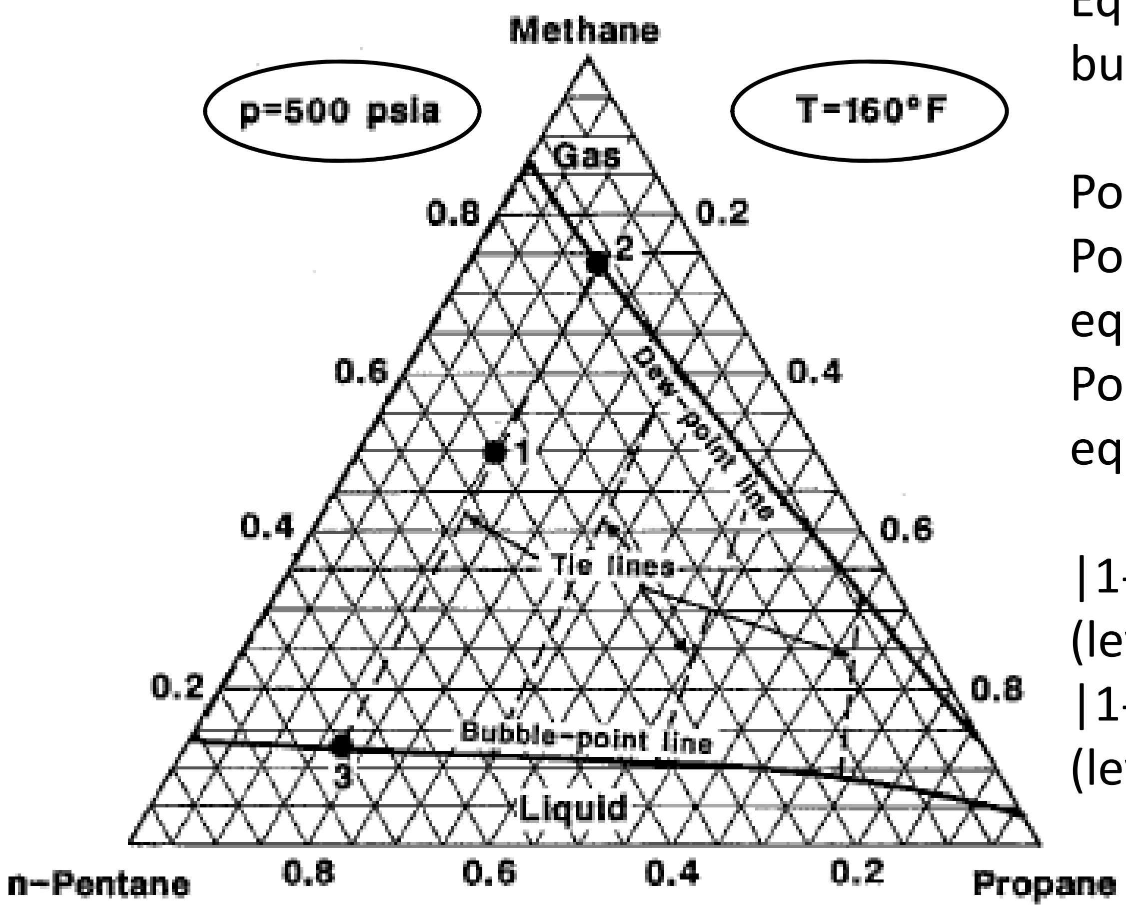
Line 2-1: Dilution line, adding B to the original mixture of A and C at Point 2

Point 7: 50% Point 2 + 50% B

INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

Phase Diagram for a Three-Component Substance (C_1, nC_3, nC_5)



Equilibrium tie-lines are straight but not horizontal

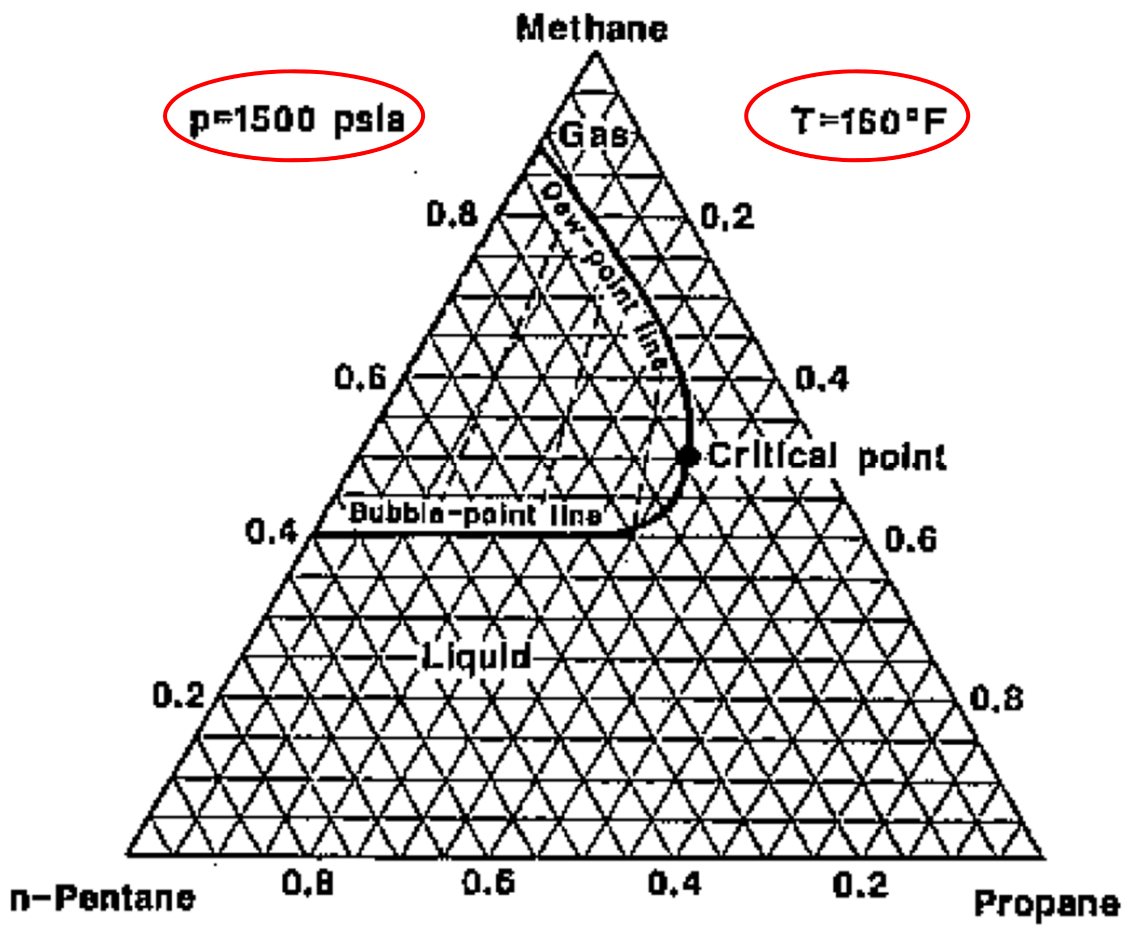
Point 1: mixture of C_1, C_3, C_5
Point 2: Composition of equilibrium gas
Point 3: Composition of equilibrium liquid

|1-3|/|2-3|: quality of gas (lever rule)
|1-2|/|2-3|: quality of liquid (lever rule)

INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

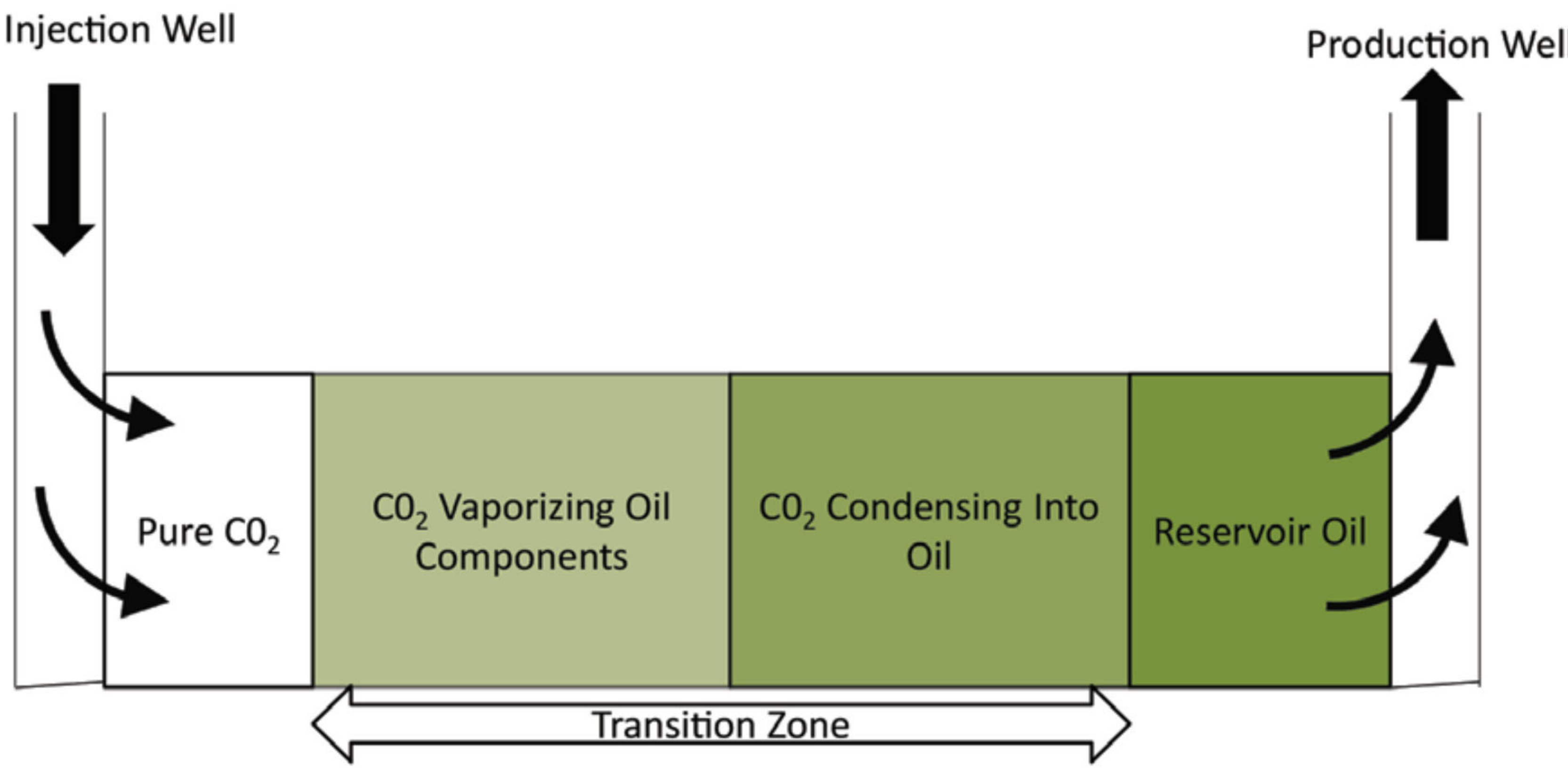
Phase Diagram for a Three-Component Substance (C_1, nC_3, nC_5)



INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

Multi-Contact Miscibility



Schematic of the CO2 (carbon dioxide) miscible process showing the transition zone between the injection and production well. (Modified from Jarrell et al., 2002.)

INFORMATION BOX

- PVT relationship modeled with an equation of state (EOS)

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

When we inject CO_2 into an oil reservoir, it becomes mutually soluble with the residual crude oil

Light hydrocarbons from the oil dissolve in the CO_2 and CO_2 dissolves in the oil. This occurs most readily when the CO_2 density is high (when it is compressed) and when the oil contains a significant volume of “light” (i.e., lower carbon) hydrocarbons (typically a low-density crude oil).

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

As the CO2 sweeps across the reservoir and mixes with the oil, it also causes it to swell. This allows more oil to flow to the producing well

As CO2 dissolves in the oil it swells the oil and reduces its viscosity; affects that also help to improve the efficiency of the displacement process.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

Often, CO_2 floods involve the injection of volumes of CO_2 alternated with volumes of water; water alternating gas or WAG floods.

This approach helps to mitigate the tendency for the lower viscosity CO_2 to finger its way ahead of the displaced oil or to over-ride the oil. Once the injected CO_2 breaks through to the producing well, any gas injected afterwards will follow that path, reducing the overall efficiency of the injected fluids to sweep the oil from the reservoir rock.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

What is needed for a CO_2 project?

CO_2 Source: First, a pipeline to deliver CO_2 to the field at a high pressure and density (>1200psi and 5 pounds per gallon) for the project– for comparison water density is 8.3 pounds per gallon).

Simulation / pattern design: This CO_2 is directed to injection wells strategically placed within the pattern of wells to optimize the areal sweep of the reservoir. The pattern of injectors and producers can change over time and will typically be determined based on computer simulations that model different design scenarios.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

What is needed for a CO_2 project?

Monitoring system: At the producing wells, fluids are piped to a centralized collection facility. A well manifold allows for individual wells to be tested to see how much oil, gas and water is being produced at each location and if the concentration of oil is increasing as the oil bank reaches the producing wells

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

What is needed for a CO_2 project?

Surface separation facilities: The produced fluids are separated and the gas stream, which may include amounts of CO_2, must be further processed. Any produced CO_2 is separated from the produced natural gas and re-compressed for re-injection along with additional volumes of newly-purchased CO_2.

In some situations, separated produced water is treated and re-injected, often alternating with CO_2 injection, to improve sweep efficiency (the WAG process mentioned earlier).

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

- However, since CO_2 is less dense than water or oil, it tends to rise to the top of the reservoir and bypass large quantities of oil on its path to the producer, or to finger through due to its lower viscosity.
- To combat this, the CO_2 is often injected in slugs alternated with water, in a process known as water alternated with gas (WAG)
- This process tends to spread out the flood front, thereby increasing the sweep efficiency

Tertiary Production Phase

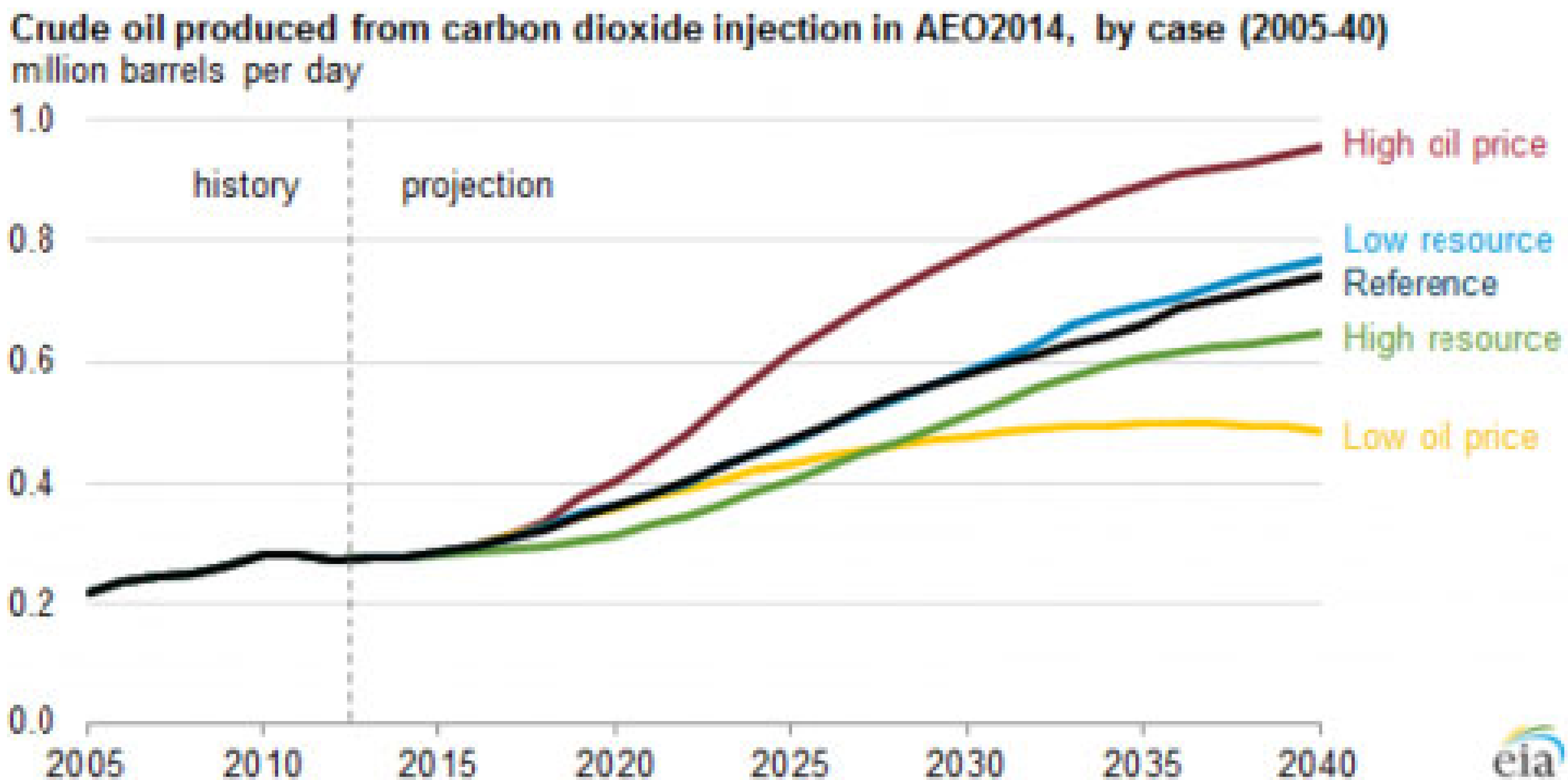
Enhanced Oil Recovery (EOR) using CO_2 Injection

Other approaches that have been developed include:

- Surfactant Alternating Gas (SAG) – Foam generated in the reservoir can address the high-permeability streaks to improve sweep efficiency
- Low-viscosity foam with CO_2 gas to keep the gas from migrating upward

- There are other drawbacks to using CO_2:
  - Corrosion

Tertiary Production Phase
Enhanced Oil Recovery (EOR) using CO2 Injection



01 Learning from CO2 use in the Permian Basin

- Rules of thumb: what are they based on?
- Historic and current CO2 use in PB

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

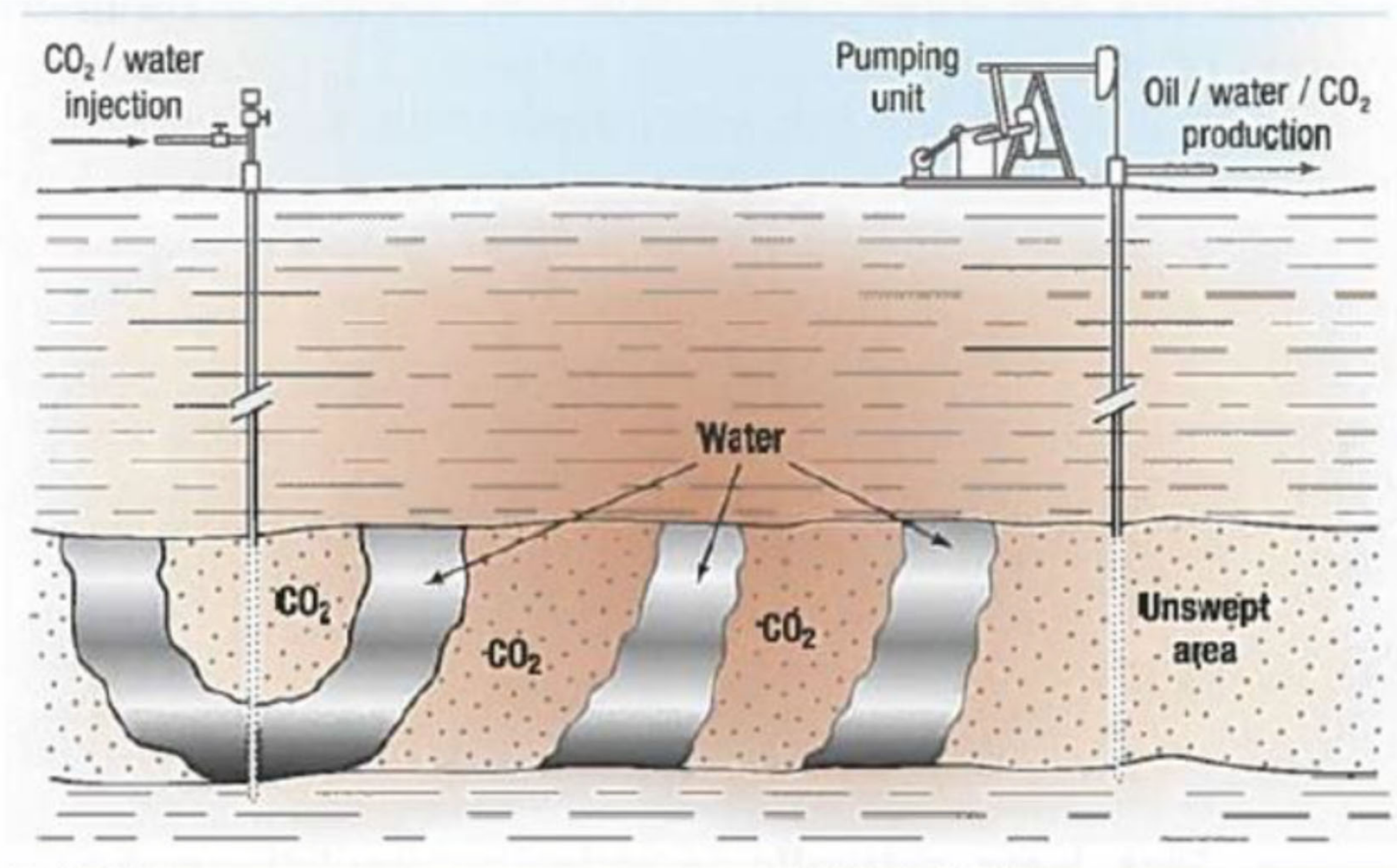


Fig. 9–19. **Cross section of a WAG (water alternated with gas) project.** In this case, the gas is CO_2.

01 Learning from CO2 use in the Permian Basin

- Rules of thumb: what are they based on?
- Historic and current CO2 use in PB

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

01 Learning from CO2 use in the Permian Basin

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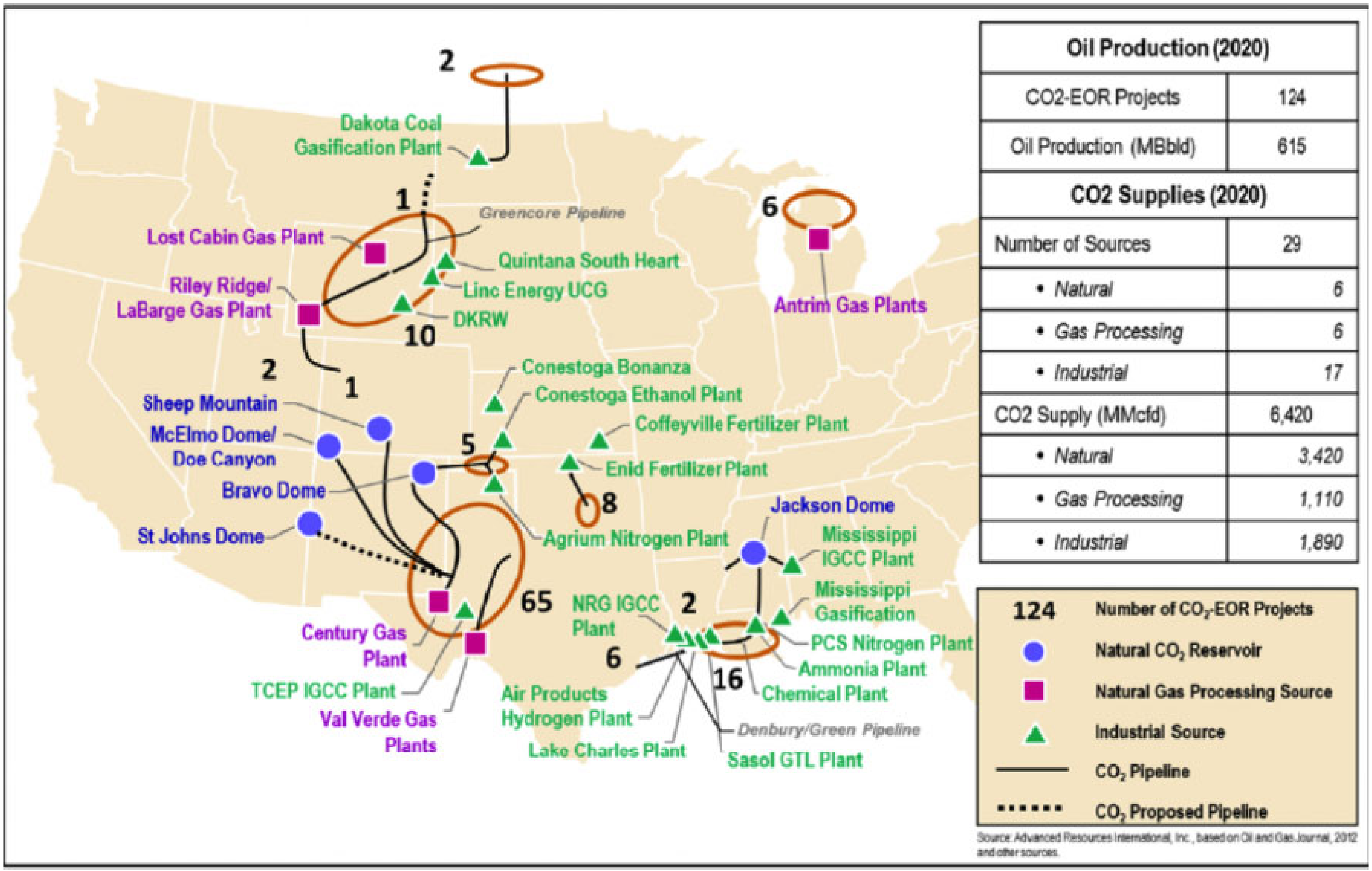
Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection



Oil Production (2020)	
CO2-EOR Projects	124
Oil Production (MBbld)	615
CO2 Supplies (2020)	
Number of Sources	29
• *Natural*	6
• *Gas Processing*	6
• *Industrial*	17
CO2 Supply (MMcfd)	6,420
• *Natural*	3,420
• *Gas Processing*	1,110
• *Industrial*	1,890

Source: Advanced Resources International, Inc., based on Oil and Gas Journal, 2012 and other sources.

01 Learning from CO2 use in the Permian Basin

- Rules of thumb: what are they based on?
- Historic and current CO2 use in PB

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

The Permian Basin covering West Texas and SE New Mexico has the lion's share of the world's CO2 EOR activity for two reasons:

1. reservoirs there are particularly amenable to CO2 flooding
2. large natural sources of high purity CO2 are relatively close

However, a growing number of CO2 EOR projects are being launched in other regions, based on the availability of low cost CO2

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

Screening Reservoirs for CO_2 EOR:
What kinds of reservoirs are most suitable?

In theory, any type of oil reservoir (carbonate or sandstone) could be suitable provided that:

1. the minimum miscibility pressure can be reached
2. there is a substantial volume of residual crude oil remaining
3. the ability of the CO_2 to contact the crude oil is not hindered by geological complexity

Tertiary Production Phase
Enhanced Oil Recovery (EOR) using CO_2 Injection

Screening Reservoirs for CO_2 EOR:
What kinds of reservoirs are most suitable?

Most of the large reservoirs in the Permian Basin are carbonate formations—typically limestone or dolomite—that produce from depths of 3,000 to 7,000 feet, and have undergone extensive waterflooding.

Post-waterflood recovery could be 30 to 45 percent of the OOIP, with relatively high residual oil saturation. A successful CO_2 EOR project could add another 5 to 15 percent of OOIP to the ultimate recovery.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

Screening Reservoirs for CO2 EOR Suitability	
Depth, ft	2,000 to 9,800
Temperature, °F	>250
Pressure*, psia*	above 1,200
Permeability*, mD*	above 1
Oil gravity, °API	above 27
Viscosity, cp	below 12
S_{or}, fraction of pore space (after waterflood)	>0.25

01 Learning from CO2 use in the Permian Basin

- Rules of thumb: what are they based on?
- Historic and current CO2 use in PB

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

Screening Reservoirs for CO_2 EOR:
What kinds of reservoirs are most suitable?

In theory, any type of oil reservoir (carbonate or sandstone) could be suitable provided that:

4. rock and fluid characteristics
5. past production behavior and response to waterflooding
6. detailed geological assessments
7. reservoir depth

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

Screening Reservoirs for CO2 EOR:
What kinds of reservoirs are most suitable?

In theory, any type of oil reservoir (carbonate or sandstone) could be suitable provided that:

8. oil gravity

9. reservoir pressure

10. reservoir temperature

11. oil viscosity

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

NOTES: CO2 Availability

Although the large Permian Basin reservoirs were readily recognized as ideal candidates for miscible flooding through CO2 injection, it was the ready availability of a low-cost source of CO2 that drove the Permian Basin's EOR boom in the 1970s and 1980s.

The first commercial flood occurred in Scurry County, Texas, in 1972, in what was known as the SACROC Unit (SACROC stands for Scurry Area Canyon Reef Operators Committee). For this project, the operator (Chevron) recovered CO2 from natural gas processing plants in the southern part of the basin (that would have otherwise been vented) and transported the gas 220 miles for injection at SACROC.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

NOTES: CO_2 Availability

The technical success of this project, coupled with the high oil prices of the late 1970s and early 1980s, led to the construction of three major CO_2 pipelines connecting the Permian Basin oil fields with natural underground CO_2 sources (Sheep Mountain, McElmo Dome, and Bravo Dome.

Construction of the pipelines spurred an acceleration of CO_2 injection activity in Permian Basin fields.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

NOTES: CO_2 Availability

Industry has spent more than $1 billion on 2,200 miles of CO_2 transmission and distribution pipeline infrastructure in support of CO_2 flooding in the Permian Basin.

Typically, it costs $0.25-0.75 per thousand cubic feet to transport CO_2 to West Texas fields from the sources to the north. With a substantial CO_2 pipeline and distribution infrastructure in place, Permian Basin operators have spread the costs among several large fields, and the infrastructure in these “anchor” fields in turn has helped reduce the cost of delivered CO_2 to smaller fields in the basin.

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO_2 Injection

Anthropogenic CO_2 Sources

For years, ExxonMobil has sold CO_2 from its La Barge, Wyoming gas processing facility to area oil producers for use in CO_2 EOR projects. The company currently captures 4 million metric tons of CO_2 annually for this purpose.

Why sequester CO_2?

- 1 metric ton of CO_2 equals 545 cubic meters (19.25 Mcf)at standard conditions of 14.7 psi and 70 °F
- The average American car emits about seven metric tons of CO_2 per year

Tertiary Production Phase

Enhanced Oil Recovery (EOR) using CO2 Injection

- Prerequisites for a successful CO2 flood are reservoirs at depths in excess of at least 2,500ft (so that the high injection pressures are contained), and oil gravities of at least 22API
- Most CO2-EOR projects are conducted in a reservoir that is being or has been waterflooded
- Well-designed CO2 projects can recover an additional 20% of the oil originally in place
- Primary production, plus waterflooding, followed by CO2 flooding may recover as much as 60% of the total oil in the reservoir
- The recent capture of CO2 from hydrocarbon-burning industrial sites and power plants provides another source; it can be piped from these sites to appropriate oil-recovery projects

The Eagle Ford Shale

Eagle Ford Shale

The Eagle Ford Shale is a hydrocarbon–producing formation of significant importance. It is capable of producing both gas and more oil than other traditional shale plays. It contains a much higher carbonate shale percentage: upwards of 70% in south Texas. It becomes shallower and the shale content increases as it moves to the northwest.

The high percentage of carbonate makes it more brittle and "frac-able". The Eagle Ford Shale play trends across Texas from the Mexican border up into East Texas, roughly 50 miles wide and 400 miles long with an average thickness of 250 feet. It is Cretaceous in age resting between the Austin Chalk and the Buda Lime at a depth of approximately 4,000 to 12,000 feet. It is the source rock for the Austin Chalk and the giant East Texas Field according to the RRC.

CARBONATE ROCK

Sedimentary rock formed primarily from calcium carbonate ($CaCO_3$) deposited in a marine environment; most commonly limestone. Many of the carbon dioxide floods found in the Permian Basin of West Texas are in oil reservoirs in carbonate formations deposited during the Permian Period.

SHALE IOR
Improved Oil Recovery

Your IOR Service Provider

Eagle Ford Shale: Gas Injection EOR

CCUS

September 2019

02 Developing new knowledge for CO_2 use in the Eagle Ford shale

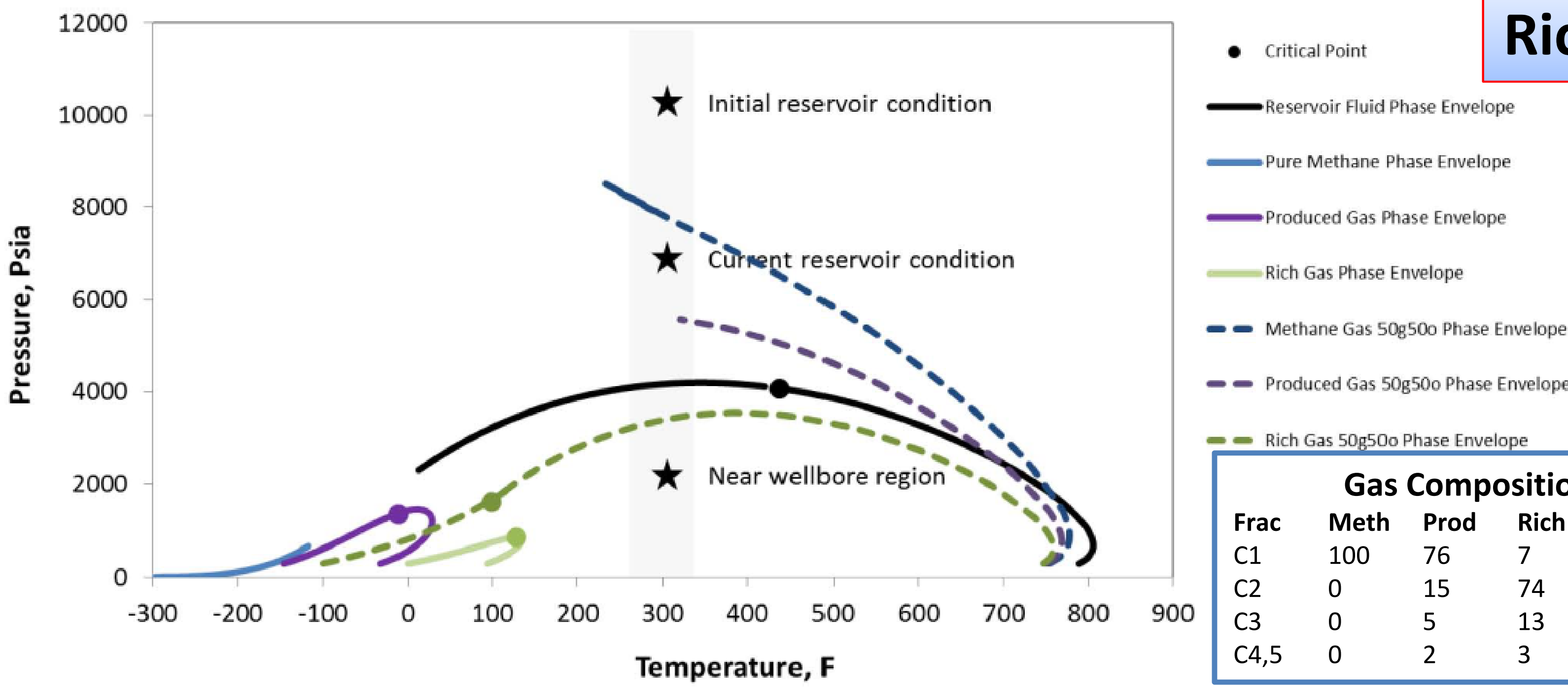
- Location
- Current gas injection projects
- Is there a potential for CO_2?

Shale Cyclic Gas Injection: Process

- Inject hydrocarbon gas at high pressure
  - Swell, vaporize, and mobilize: Single Phase Flow above critical condition
  - Primarily cyclic injection > Servicing the SRV (Wells & fracture network)
  - Matrix penetration > 1 foot / year (project life 15+ years)
- Process is compositional: Known Technology
  - Process: PVT Phase behavior > void of displacement
  - Oil Wells > Gas condensate Wells
  - Inject Low Btu > Produce High Btu
  - Application to Unconventional NEW > Must think outside the BOX

SPE 191673 Which Gas > higher recovery?

Rich Gas



Gas Compositions

Frac	Meth	Prod	Rich
C1	100	76	7
C2	0	15	74
C3	0	5	13
C4,5	0	2	3

Figure 29—Summary of the phase envelope with different injectant gases (pure Methane, Produced Gas, Rich Gas) and reservoir fluid at 50:50 mixture.

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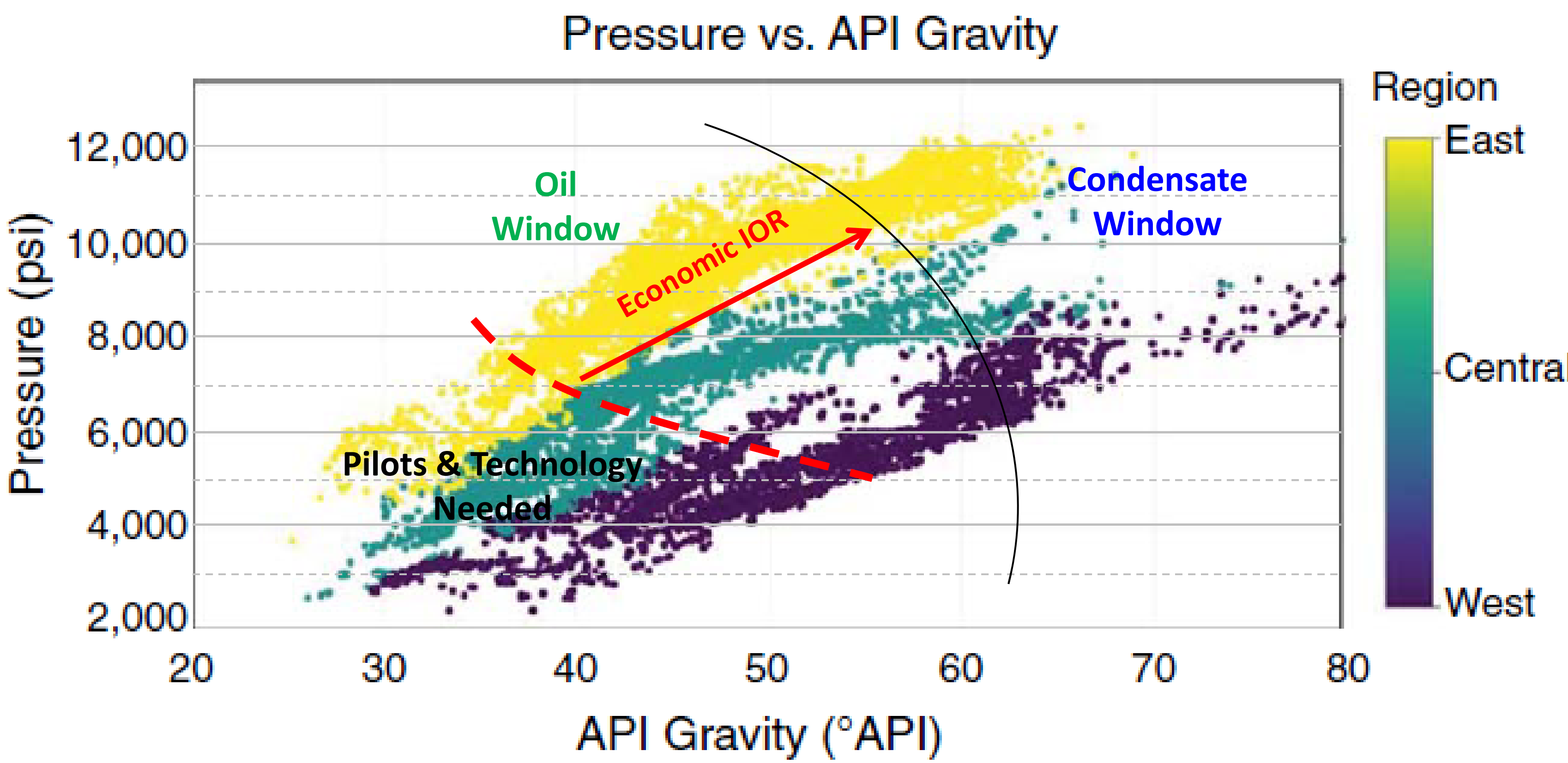

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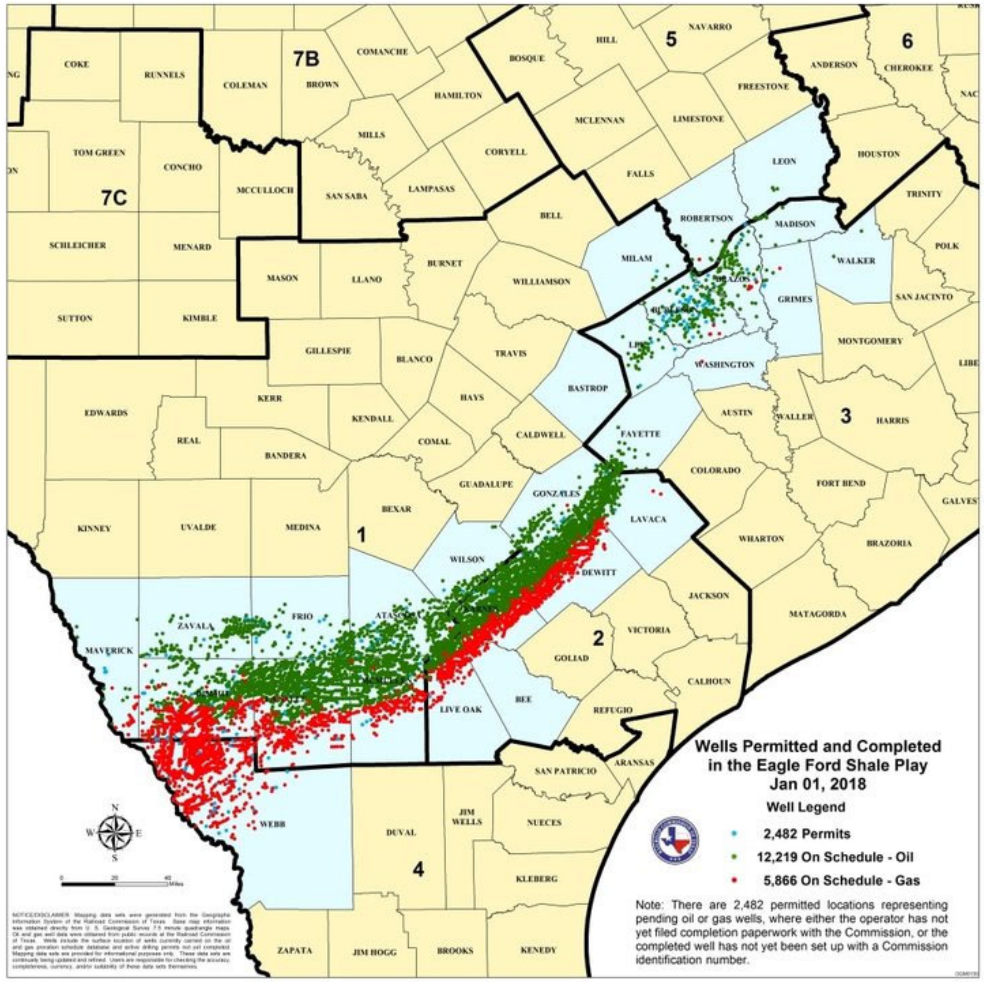

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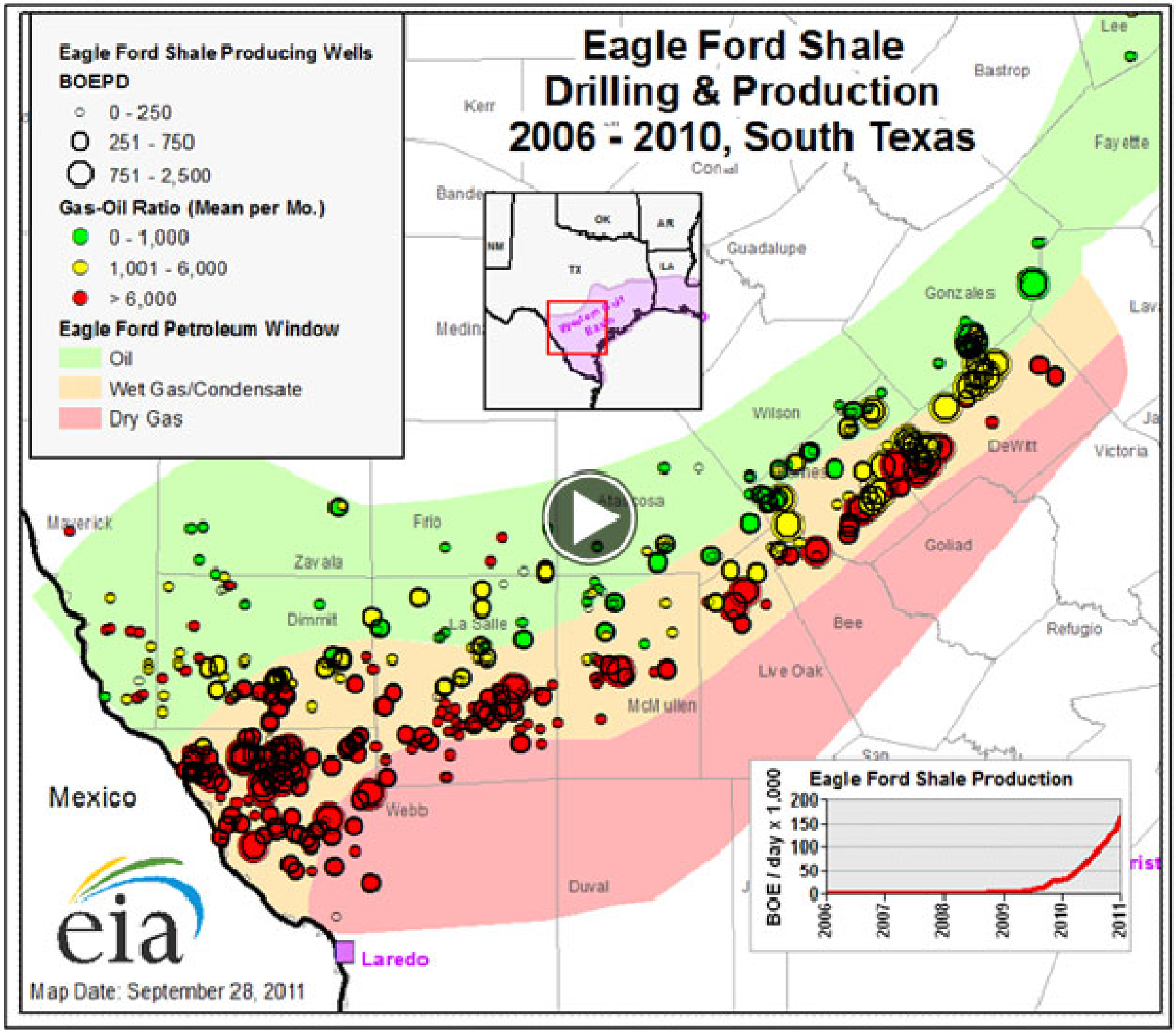

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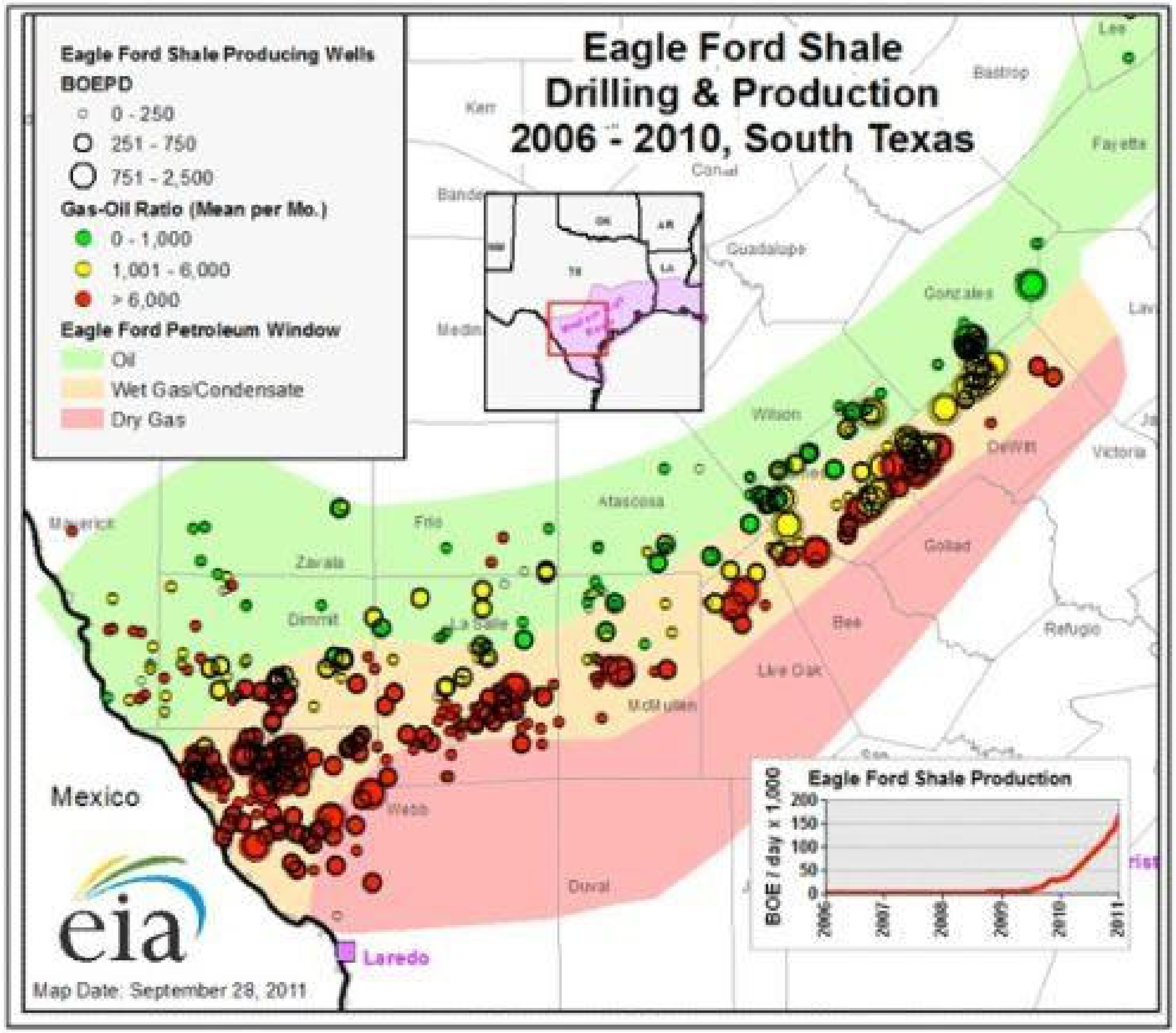

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Eagle Ford IOR Target: Fluid/GOR

	Region	GOR Range (scf/STB)	SG (°API)	Fluid Type	
	1	0–100	10.0–30.0	oil	
	2	100–500	30.0–41.4	oil	Not Proven
No Pilots	3	500–1,000	41.4–45.8	oil	Pilot
	4	1,000–1,500	45.8–48.2	oil	
30 Projects	5	1,500–2,000	48.2–49.8	oil	Proven
	6	2,000–3,000	49.8–52.0	volatile oil	
1 Pilot	7	3,000–4,000	52.0–53.5	rich condensate	Pilot
	8	4,000–5,000	53.5–54.6	rich condensate	
	9	5,000–8,000	54.6–56.7	condensate	Not Proven
	10	8,000–15,000	56.7–59.4	condensate	
	11	15,000–50,000	59.4–63.6	condensate	
	12	>50,000	>63.6	dry gas	

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Unconventional Gas Injection Pilot Options

- Segregated Huff-n-Puff Pilot of Well or Wells (no close neighbors)
  - See EOG Eagle Ford **Martindale Pilot** as example
- Cycle Pad of Wells with commercial project in mind
  - See EOG Eagle Ford **Henkhaus** as example
- Parent to child completion IOR (2 for 1: IOR and Pilot)
  - See EOG **Steen Scruggs** as example
  - Gas injection in Parent before completion of New Child Wells
  - Reduce completion risk from depleted reservoirs
  - Pilot gas injection, solve Parent/Child, produce back highly stimulated Wells

Eagle Ford Shale
Field Results Study
Analytics to Simulation

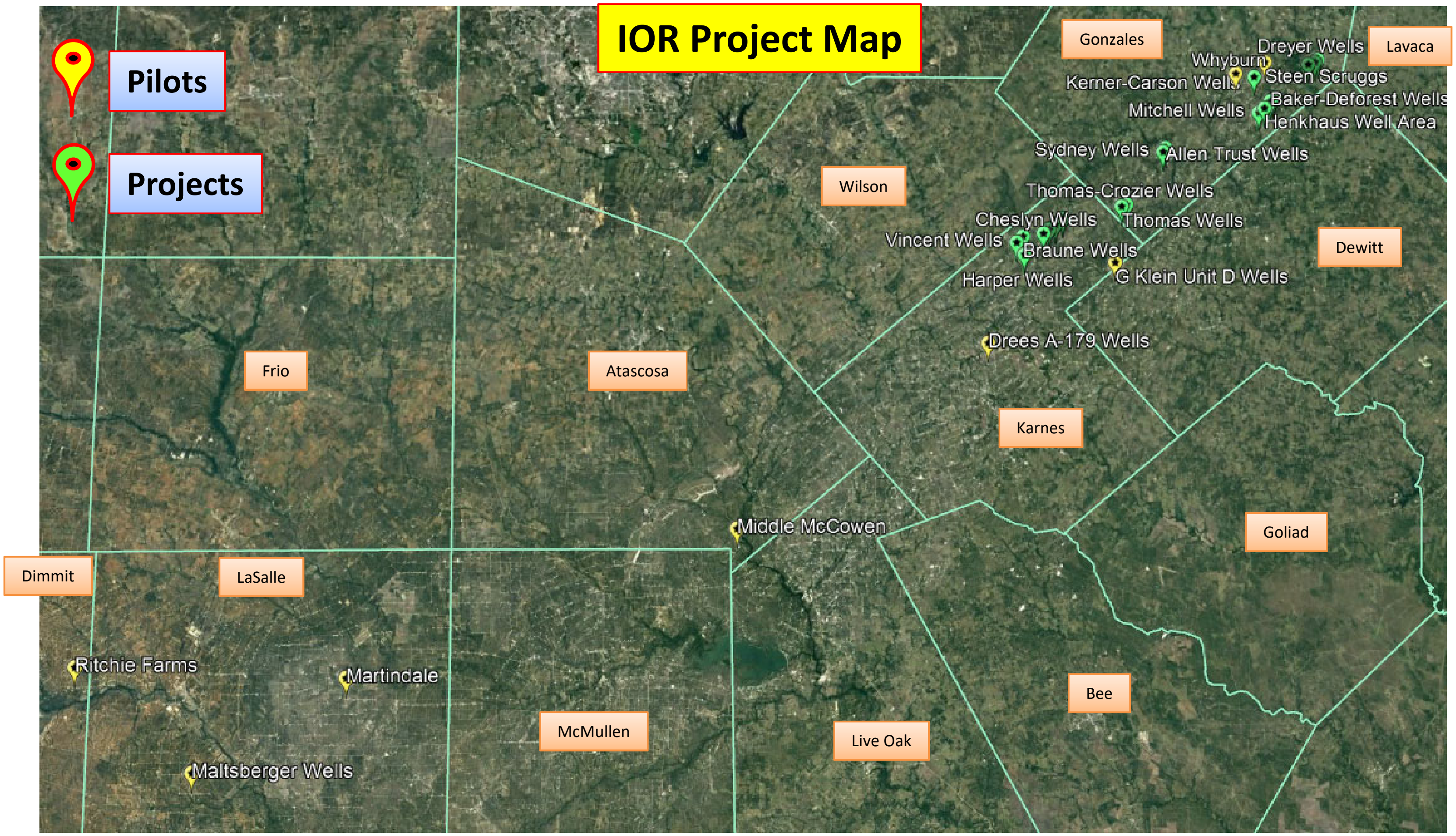
Available to Purchase

see: www.shaleior.com

Shale IOR LLC

Executive Summary: Eagle Ford CGEOR

- 6+ years of IOR history across 30 pads injecting produced gas
- Cyclic gas injection started by EOG with 1 Well in late 2012 then progressed to 4 Wells at a time with different cycles to pilot and understand reservoir and operational process
- EOG Projects progressed to 7 – 10 Wells injecting at one time
- Current projects use 4+ compressors, 20-30 Wells, and 40-50 MMscfd
- Recent pilots or projects by Marathon, ConocoPhillips, EP Energy, Murphy, and PetroEdge



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2019 Shale IOR Summary Table: EOG Eagle Ford Cyclic Gas Injection

IOR		Pad			*DCA		1st Cycle Evaluation			PI TOP
Unit name	Date	Wells #	Spacing feet	Compressor Count	Well EUR	Well IOR	Inj Well count	Pad IOR bopd	Well IOR bopd	feet
Steen Scruggs	Nov-12	1	1500+	2 >0	160	146	1	250	250	10950
Martindale	Dec-14	4	500	2 >1 >0	173	190	4	850	213	9864
Whyburn	Jan-15	8	800	3 >1 >0	170	71	4	600	150	9899
										11650
										11670
										11647
										11647
										11791
										11794
										11791
										10296
										10208
										10200
										10879
										10710
										10500
										10490
										9962
										10000

3 Pilots
16 Commercial Installations

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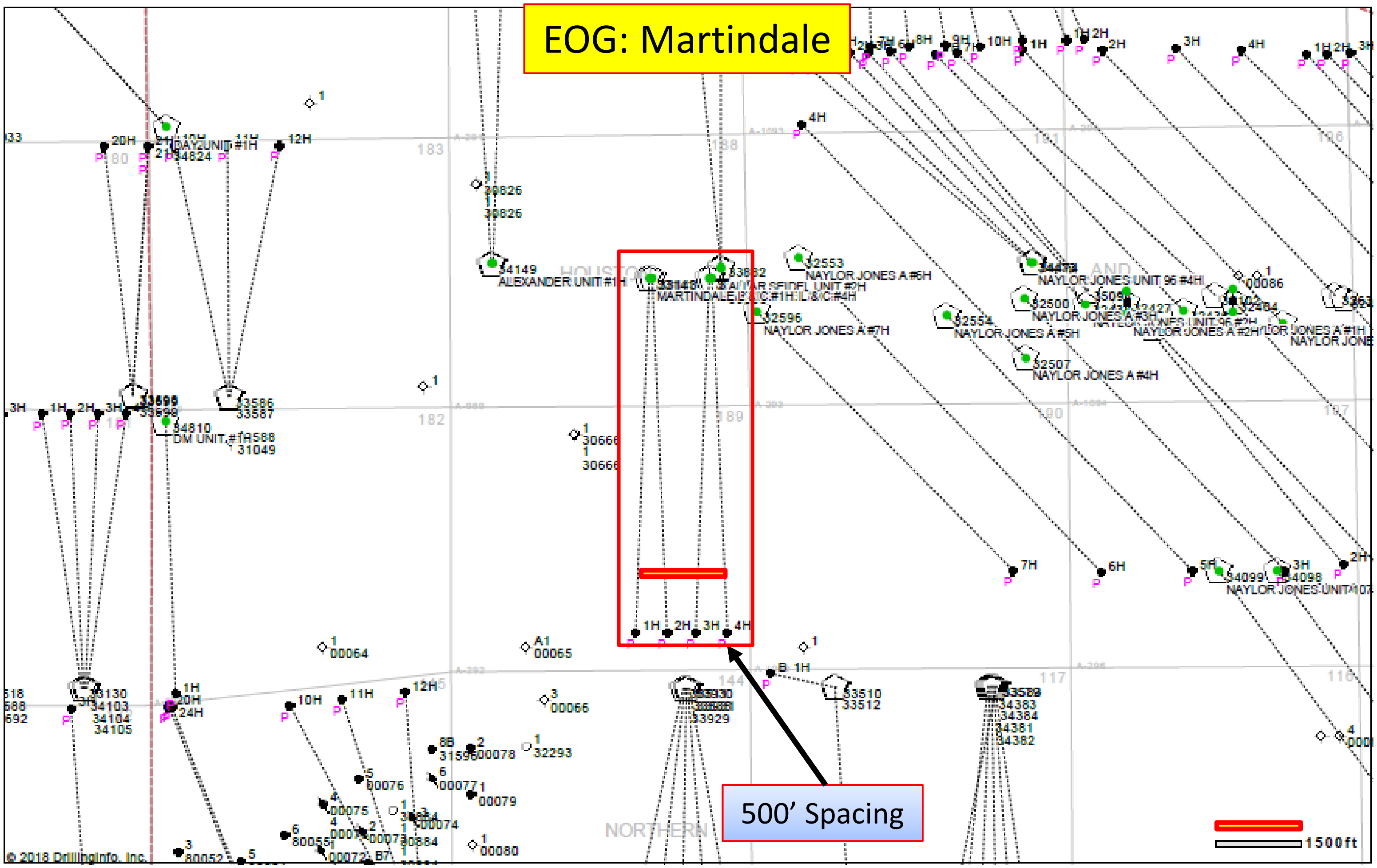
Reservoir Simulation
History Match

Eagle Ford
La Salle Co, Texas



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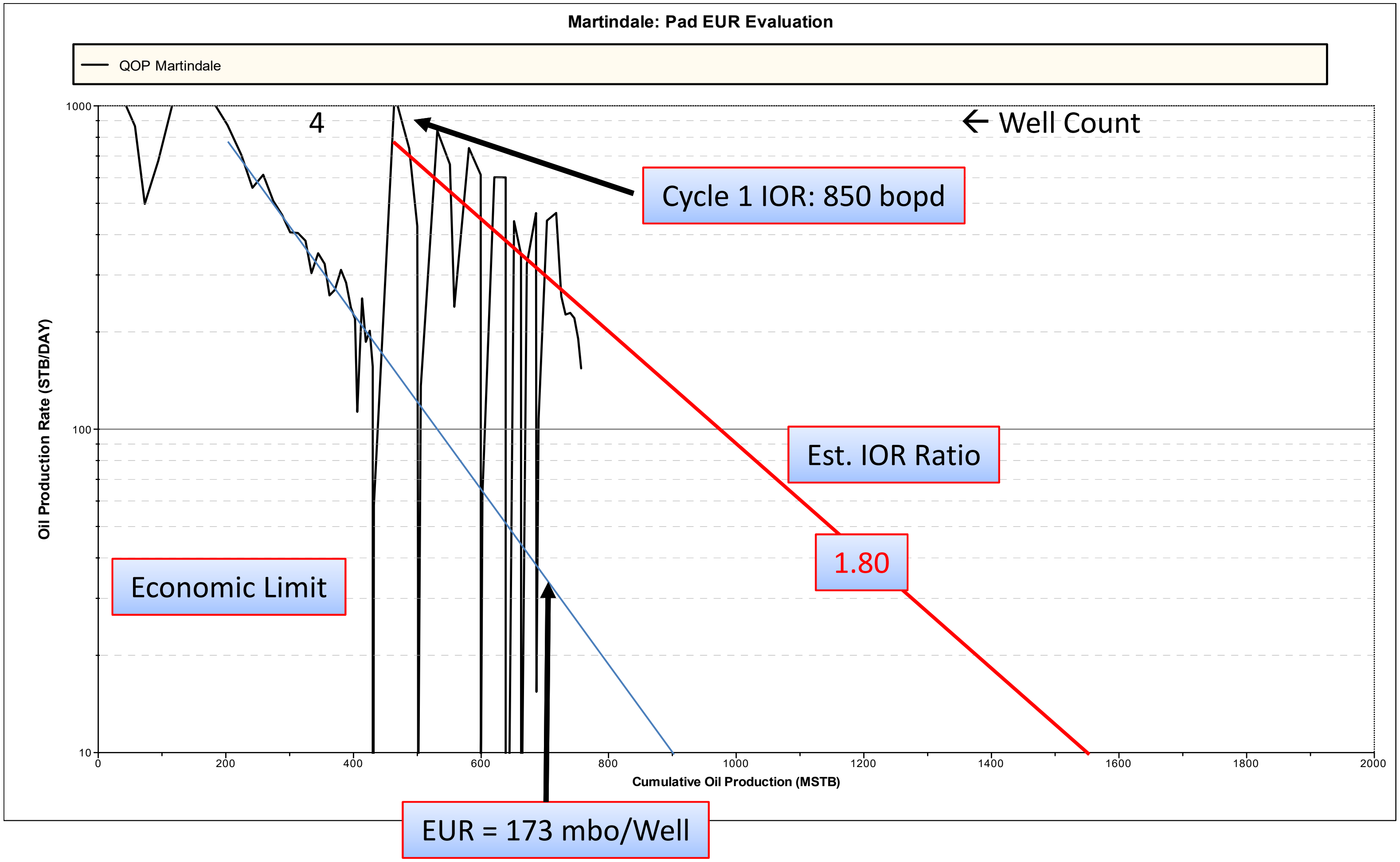

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Martindale Pilot: Simulation history match

- A significant amount of reservoir engineering has been completed to understand and guide the interpretation of IOR field history

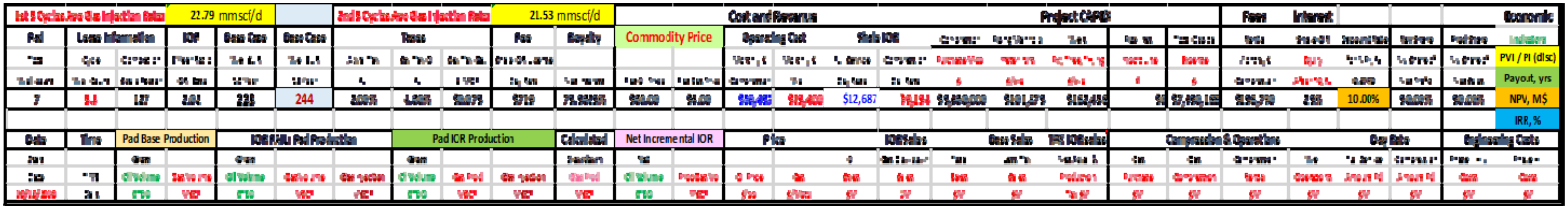
- We believe that a compositional prediction is best practice

- Shale IOR/IRT has matched the Martindale Pilot in detail and found:
  - Gas injection rates, cycle Well count, cycle times, pressure, and fill up volumes from simulation have been guided by field history and results provide a good understanding of what is being done in the field

- We believe that there is room for IOR improvement based on our compositional understanding
  - Projects are yielding IOR Ratio = 1.75+ from decline analysis and history match predictions, however simulation results also show large uplift with optimal gas composition and cycle operations

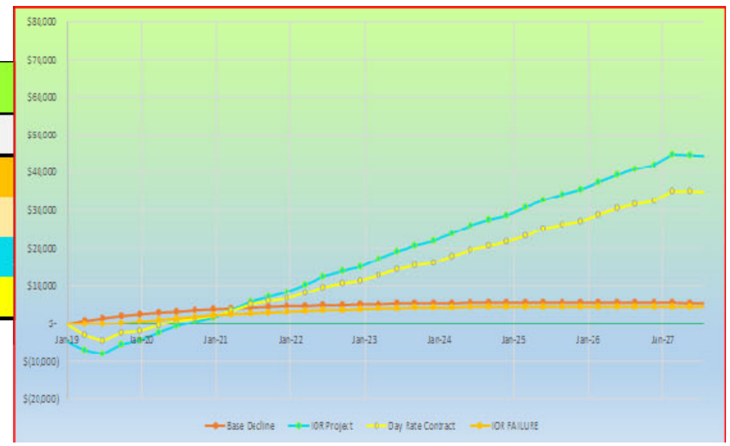
Economics

Screening Tool: Input & Output Example



Reservoir Volumes and Process Yield							Financial Net to Operator			
Well IOR and EUR		*IOR Period Production Volumes				Yield	Gas Purchased	Gas Sales	Oil Sales	**Net Yield
IOR 5yr	EUR	Gas Prod	Gas Inj	Gas Import		IOR Prod	Ratio	Import	Blowdown	Net IOR	$mcf/stbo
mbo	mbo	mcf	mcf	mcf		stbo	mcf/stbo	$M	M	$M	$/bbl
217	228	37,933,6?9	43,472,217	5,538,598		3,089,057	1.79	$16,616	$4,190	$140,050	$4.32

Project	OPERATOR $M				
	CAPEX	CF 10 Yr	CF 5 Yr	NPV 5 Yrs	NPV 10 Yrs
Base Depletion	$0	$5,176	$5,343	$4,629	$4,699
IOR Failure	$150	$4,235	$4,220	$3,373	$3,516
IOR Project	$3,817	$42,888	$22,928	$15,695	$26,967
Day Rate Contract	$150	$33,350	$16,980	$11,986	$21,374



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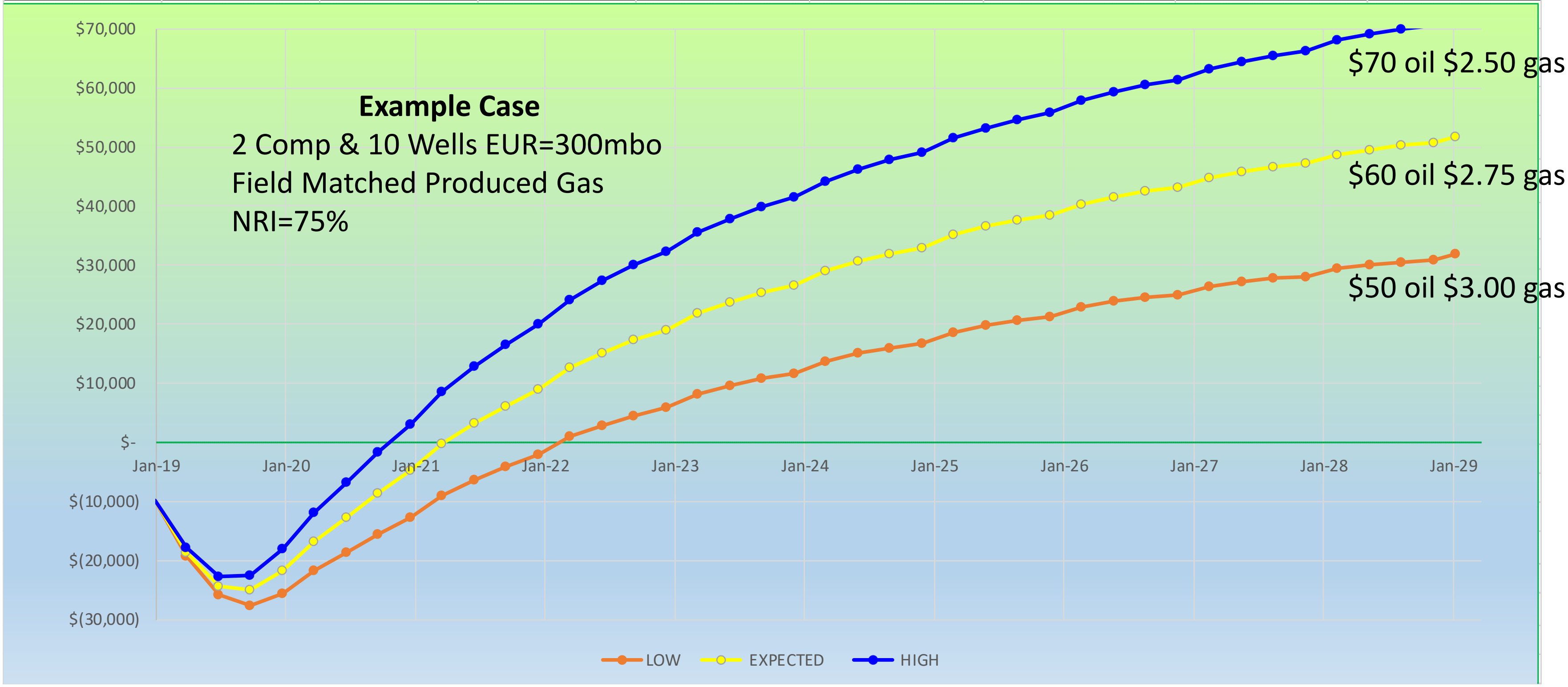
Screening Tool: Input & Output Example

Eagle Ford Economics and Cash Flow: Produced Gas EOR Project						
Project	**EOR PROJECT CASES**				**Input Variables**	
Description	**CAPEX**	**Cash Flow**	**NPV10**	**PV/I**	**Oil Price**	**Gas Price**
LOW CASE	$9,906	$25,702	$9,065	0.92	$50	$3.00
EXPECTED CASE	$9,906	$38,082	$18,488	1.87	$60	$2.75
HIGH CASE	**$9,906**	**$48,711**	**$26,727**	**2.70**	**$70**	**$2.50**



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CO2 potential in other shale plays?

Do these other shale plays meet the criteria?

Bakken Shale & Three Forks System

Appalachian Basin (Marcellus, Utica)

Haynesville (East Texas)/Louisiana)

STACK/SCOOP (Oswego, Meramec, Osage, Woodford)

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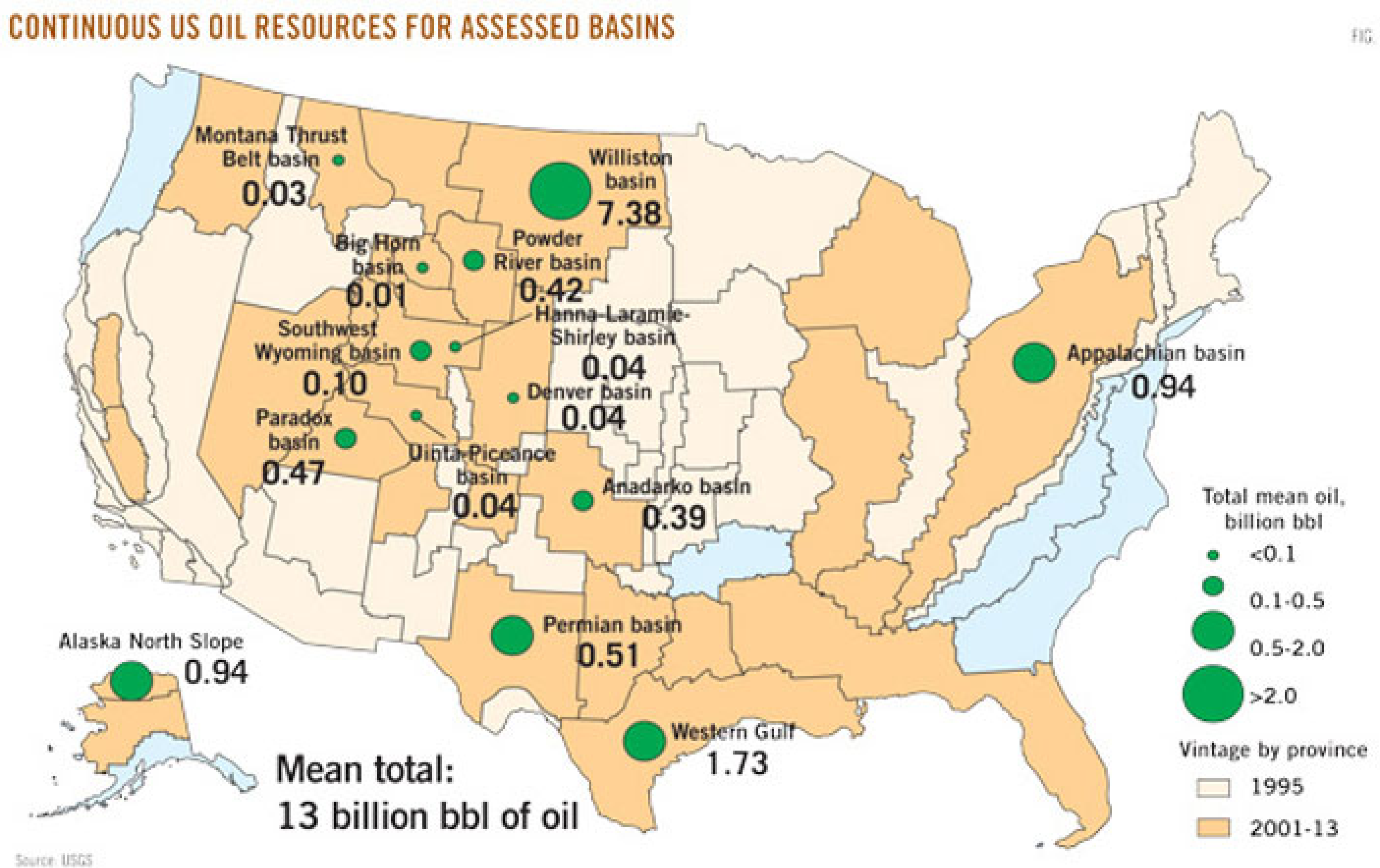

03 CO2 potential in other shale plays?