

# Bighorn Basin ROZ Development

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*Enhanced Oil Recovery Institute*

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# Acknowledgements

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Dr. Shaochang Wo

Dr. Glen Murrell

Matt Johnson



# Enhanced Oil Recovery Institute

- Created in 2004 by the Wyoming Legislature
- 20 full-time staff located at the University of Wyoming
- Encourage recovery of Wyoming's stranded oil
  - Technology development and transfer
  - Outreach
  - Field demonstrations



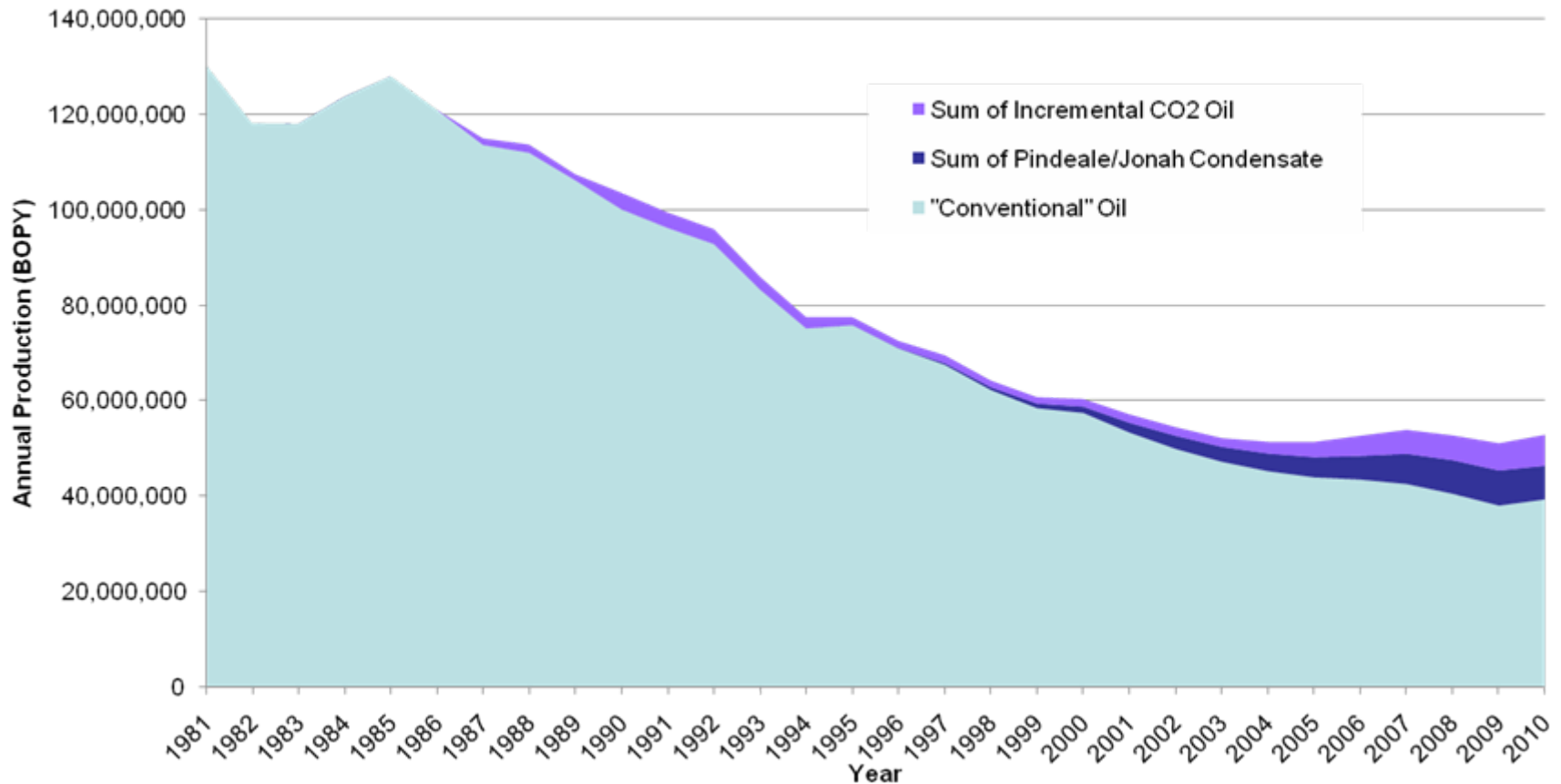
# Current Initiatives

- Initiate a consortium to develop CO<sub>2</sub> EOR in the Tensleep
- Improve characterization of natural fracturing in Tensleep reservoirs
- Improve waterflooding operations
- Support development of EOR projects with small Wyoming operators
- Support Wyoming Governor's Office with review of Resource Management Plan updates developed by the Bureau of Land Management



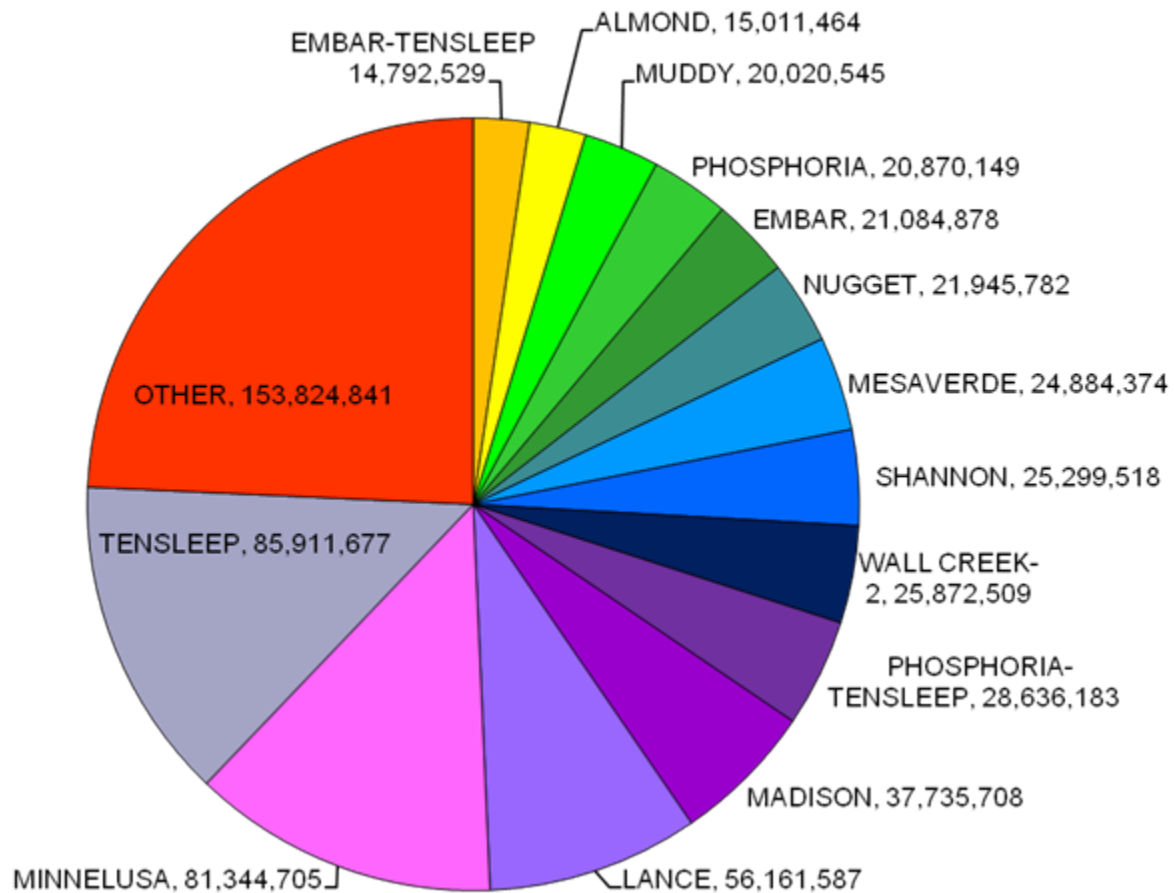
# Plot of Wyoming Oil Production

## Wyoming Production by type (BOPY)



# Summary of Oil Production in Wyoming by Formation

Wyoming Production by Reservoir (2000-2011)  
(Bbls)



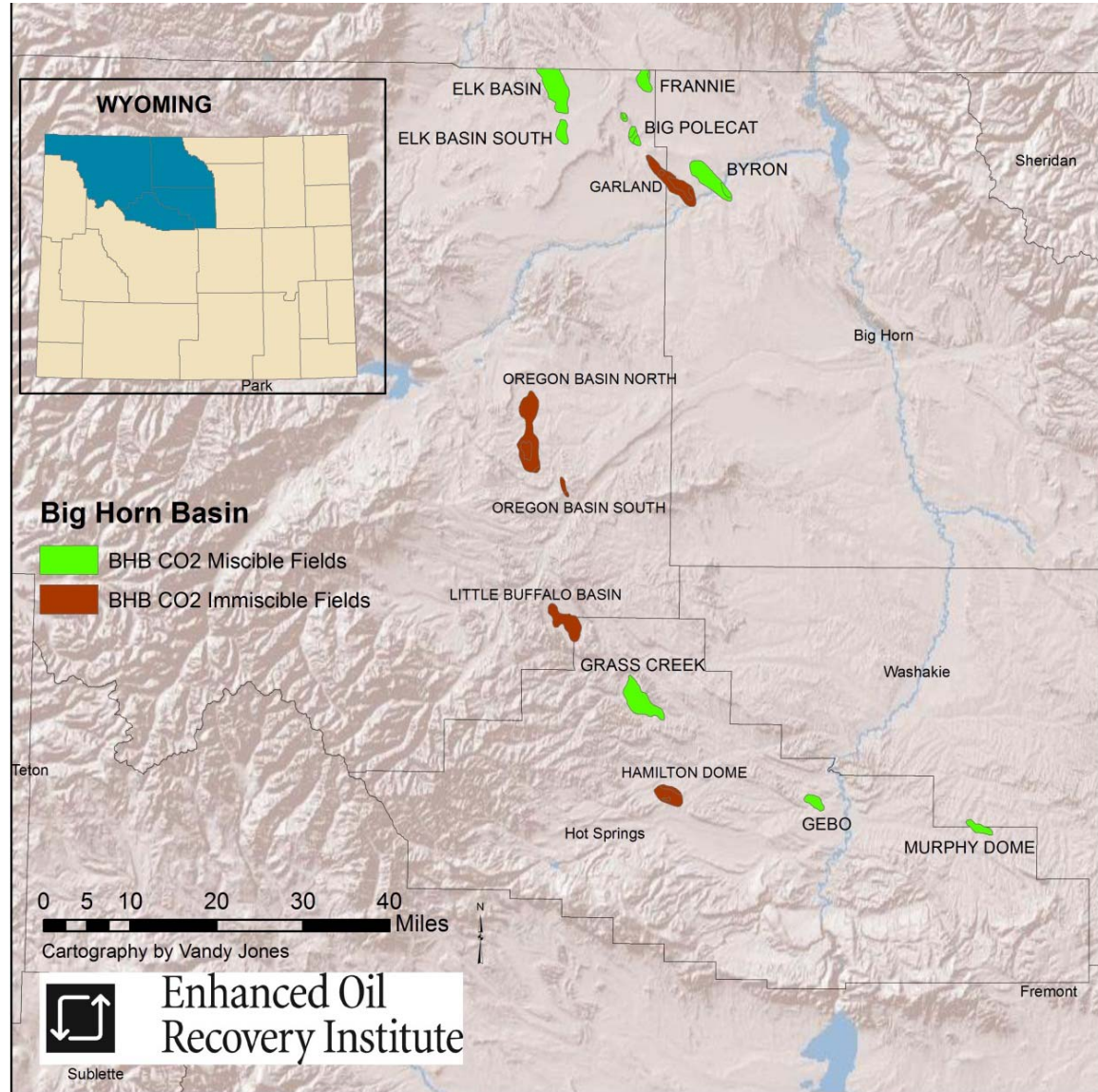
# Characteristics of Mature Tensleep Reservoirs with ROZs

- Tilted OWC
- Oil column beneath the historical defined OWC
- Oil composition
- Preliminary evaluation of miscibility
- Rough estimate of incremental oil reserves



# Bighorn Basin

(11 largest producing fields)



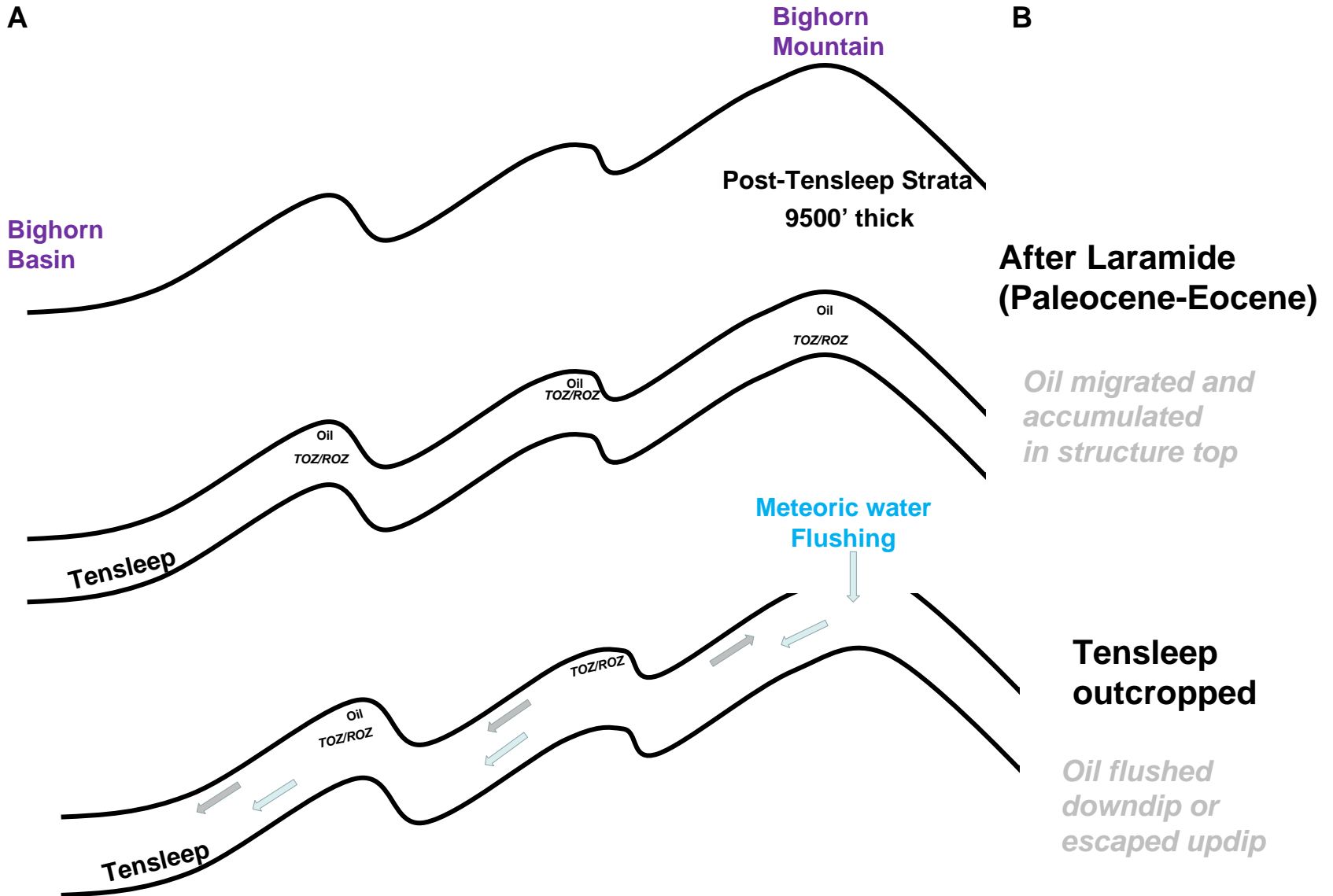
# Tensleep Reservoirs

Aufricht, 1965

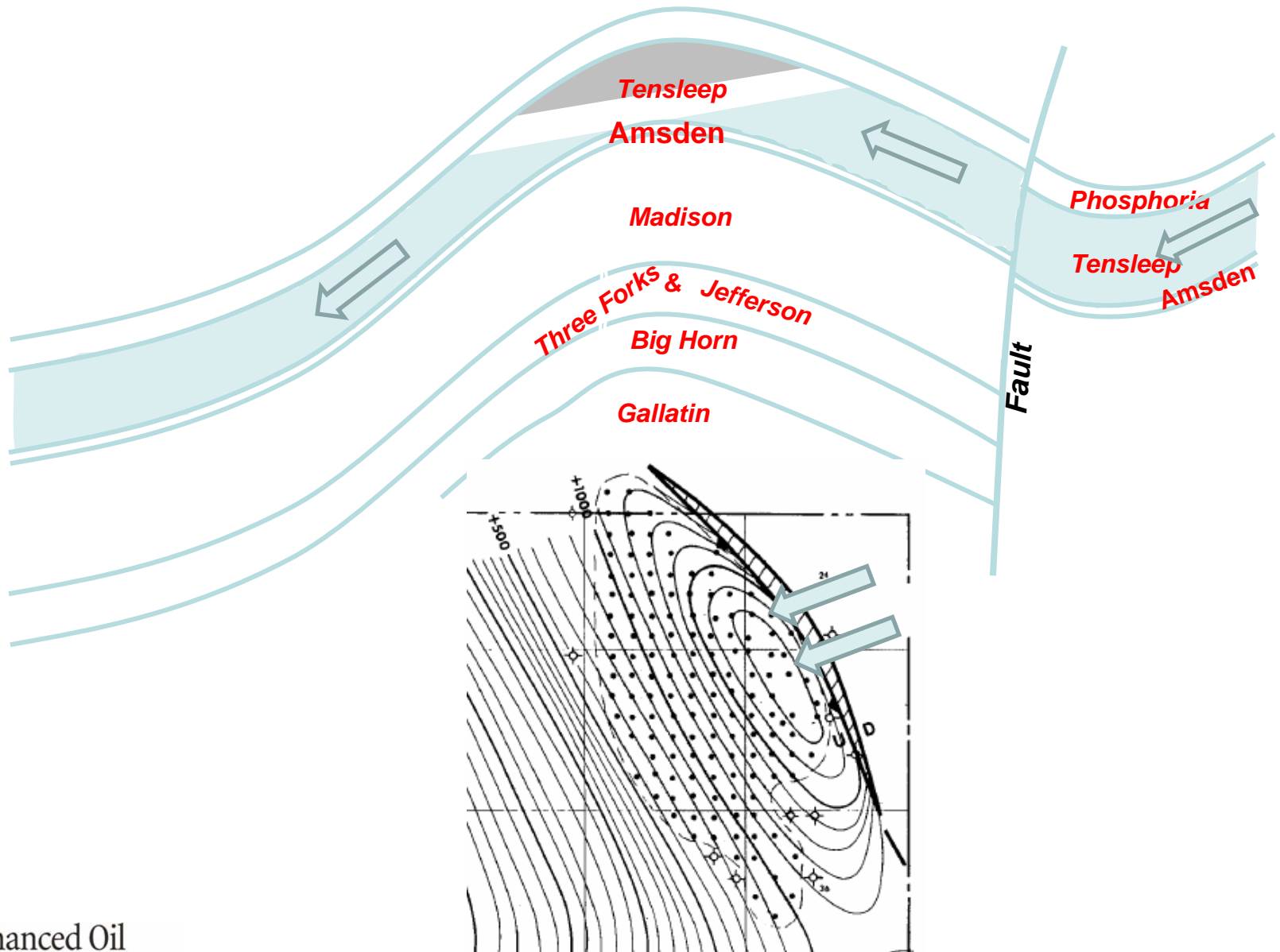
- **Oil-water transition zone of several hundred feet in thickness.**
- **Transition zone with  $S_o$  of 80% still produce with extremely high water cuts.**
- **OOIP approaching 1000 barrels per acre foot may produce at water cuts greater than 95%.**
- **Intervals with  $S_w$  of 15 to 30% are commercially of interest for primary and secondary recovery techniques.**



# Folds Created on East Flak of Bighorn Basin

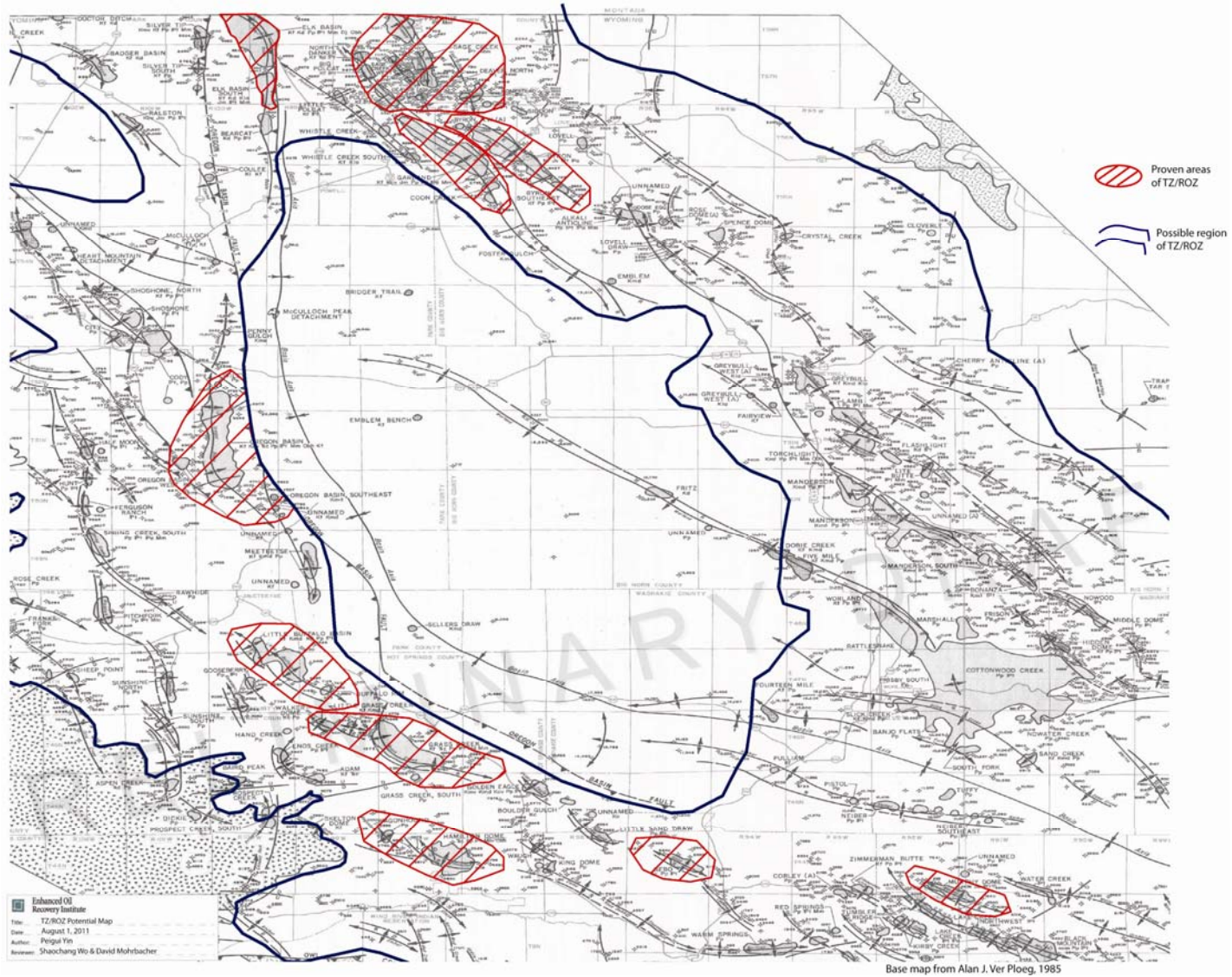


# Reservoir with Tilted OWC



# Bighorn Basin Map

Figure 4. Preliminary Mapping for Potential EOR Development of Transition and Residual Oil Zones in the Bighorn Basin, Wyoming



# Table 1. Large Big Horn Basin (Tensleep) Oil Reservoirs with Potential ROZ Resources

Table 1. Large Big Horn Basin (Tensleep) Oil Reservoirs with Potential for ROZ Resources

Field (Reservoir)	State	County	Cum. Tensleep Oil Production (MMBbls) (1-1-05)
<b>Miscible CO<sub>2</sub>-EOR Fields</b>			
1. Big Polecat (Tensleep)	WY	Park	6.2
2. Byron (Embar/Tensleep)	WY	Big Horn	119.1
3. Elk Basin (Embar/Tensleep)	WY/MT	Park/Carbon	345.4
4. Elk Basin South (Embar/Tensleep)	WY	Park	20.3
5. Frannie (Phosphoria/Tensleep)	WY	Park	133.4
6. Gebo (Tensleep)	WY	Big Horn	10.9
7. Grass Creek (Tensleep)	WY	Park	41.1
8. Murphy Dome (Tensleep)	WY	Washakie	37.4
<b>Immiscible CO<sub>2</sub>-EOR Fields</b>			
1. Garland (Tensleep)	WY	Big Horn	101.9
2. Hamilton Dome (Tensleep)	WY	Hot Springs	239.4
3. Little Buffalo Basin (Tensleep)	WY	Park	114.9
4. Oregon Basin North (Tensleep)	WY	Park	98.3
5. Oregon Basin South (Tensleep)	WY	Park	130.4

Ref: ARI



# CO<sub>2</sub> EOR Screening

Field - Reservoir	API°	Depth (ft)	Temp (°F)	Operator (most wells)
<b>MISCIBLE</b>				
Big Polecat - Tensleep	26	5500	120	CLINE PRODUCTION COMPANY
Byron - Embar/Tensleep	23	5600	130	MARATHON OIL COMPANY
Elk Basin - Embar/Tensleep	32	6250	135	ENCORE ENERGY PARTNERS (VANGUARD NATURAL RESOURCES)
Elk Basin South - Embar/Tensleep	32	7200	150	ENCORE ENERGY PARTNERS (VANGUARD NATURAL RESOURCES)
Frannie - Phosphoria/Tensleep	27	3400	100	MERIT ENERGY COMPANY
Gebo - Tensleep	24	5100	145	PHOENIX PRODUCTION COMPANY
Grass Creek - Tensleep	25	4400	115	MARATHON OIL COMPANY
Murphy Dome - Tensleep	34	4800	105	LEGACY RESERVES OPERATING LP
<b>IMMISCIBLE</b>				
Garland - Tensleep	23	4500	135	MARATHON OIL COMPANY
Hamilton Dome - Tensleep	21	3100	135	MERIT ENERGY COMPANY
Little Buffalo Basin - Tensleep	19	4900	130	CITATION OIL & GAS CORPORATION
Oregon Basin North - Tensleep	23	3400	100	
Oregon Basin South - Tensleep				

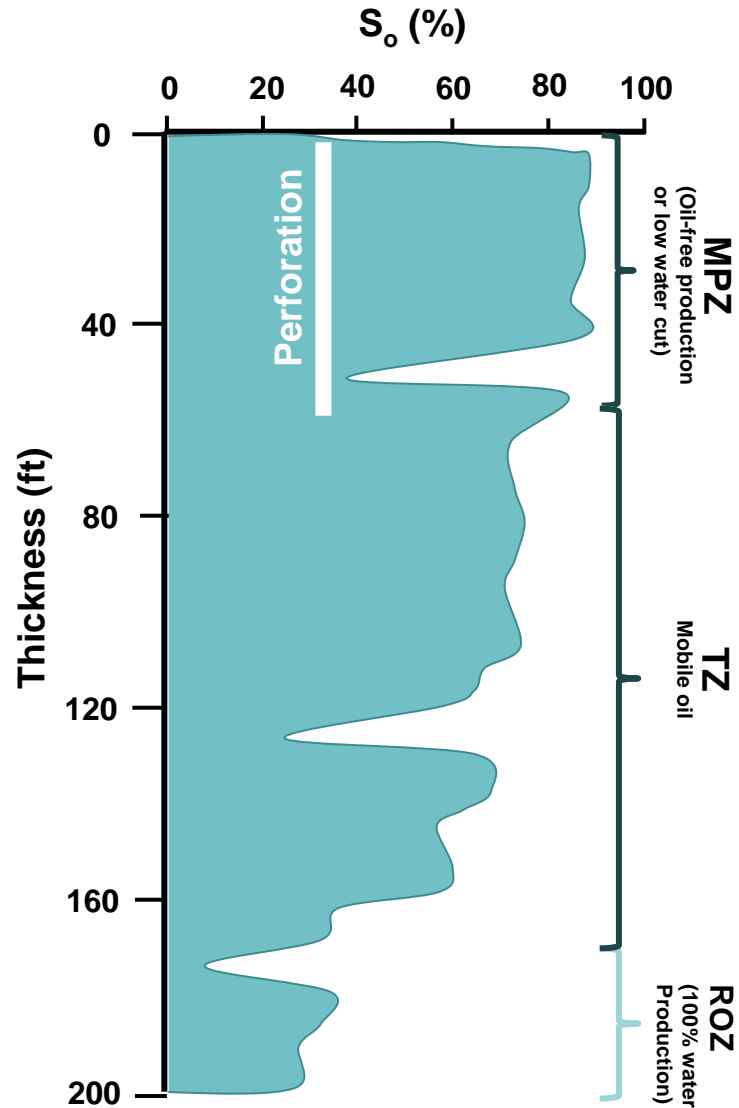


# Estimated CO<sub>2</sub> EOR Incremental Reserve Estimates

- 287,000 acres in 13 largest historic fields and areas adjacent to the fields
  - 1.3 to 2.1 billion barrels oil including MPZs pay zones and ROZs
- Additional 2.9 million acres around edge of the Bighorn Basin



# Diagram of well log



Bighorn Basin Tensleep Oil Column





# Frannie Tensleep

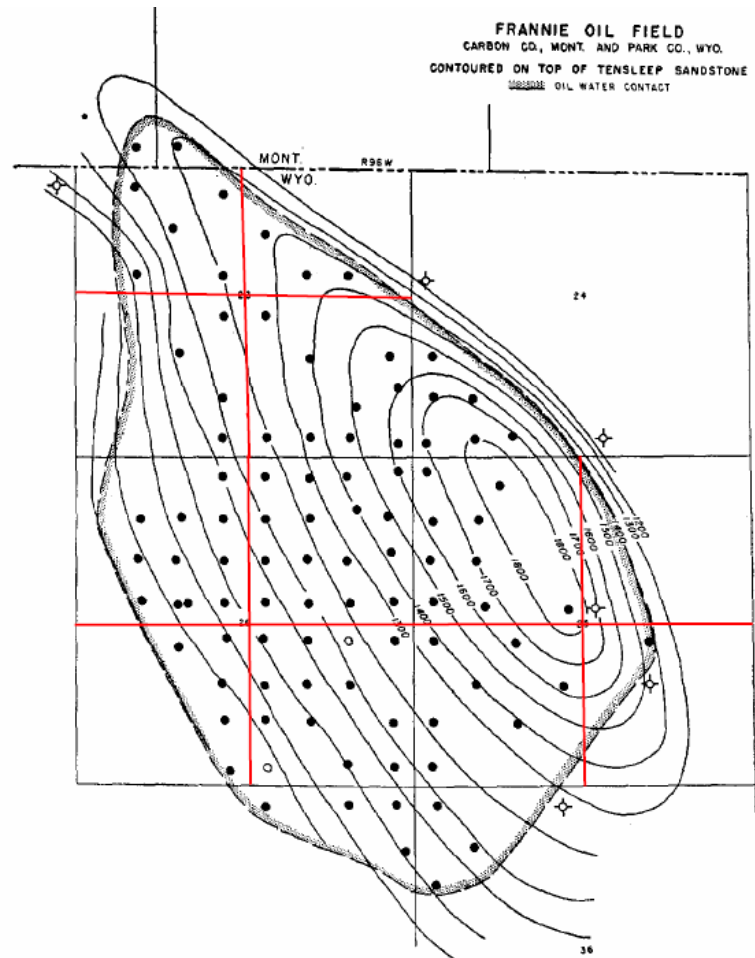
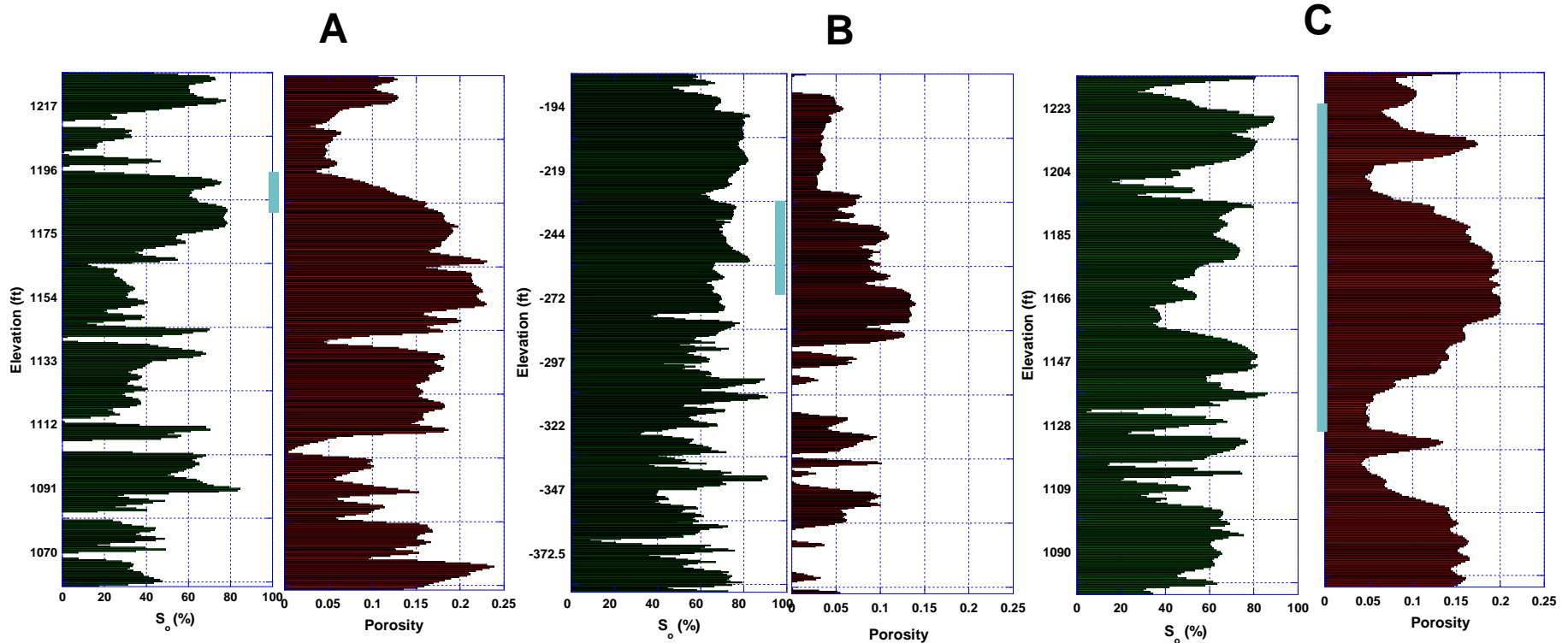


FIG. 40.—Frannie oil field, Big Horn Basin, Wyoming, showing tilt southwest.

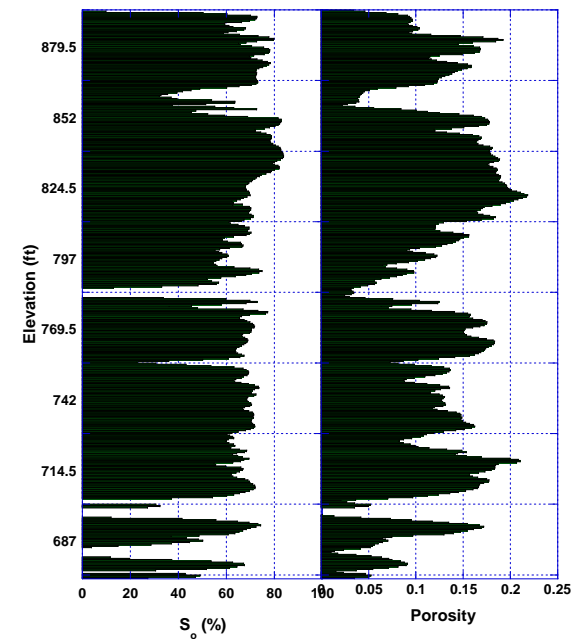
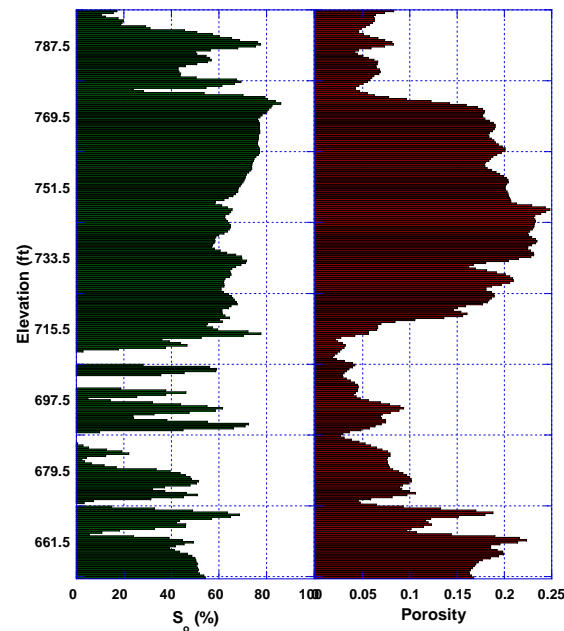
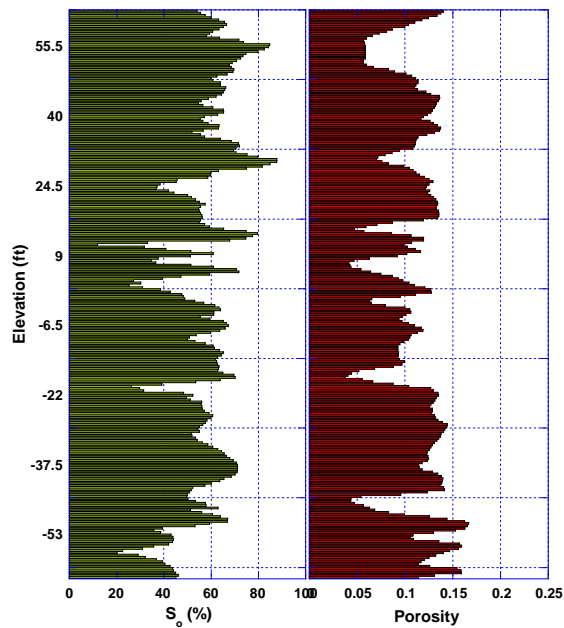
# Oil Saturation Log from Exploration Wells in Sage Creek Area



Thick permeable intervals with high  $S_o$  not produced during primary and secondary production



# Oil Saturation Log from Exploration Wells in Sage Creek Area

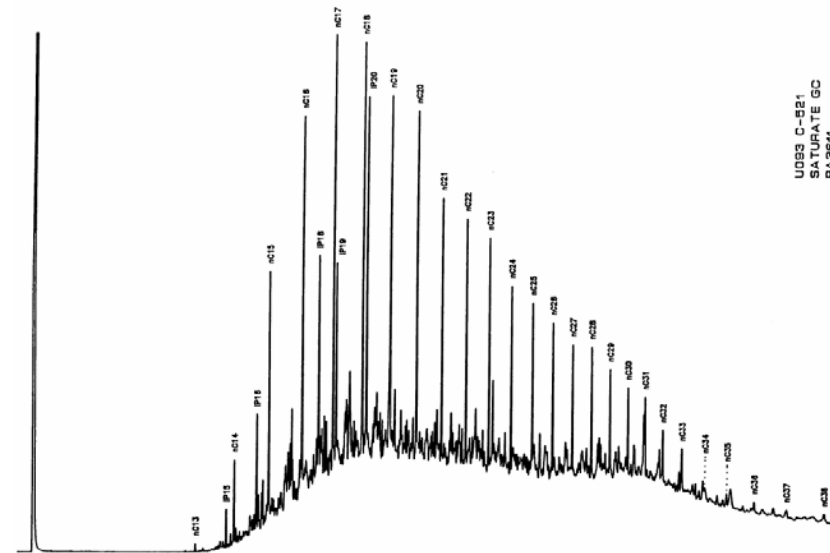
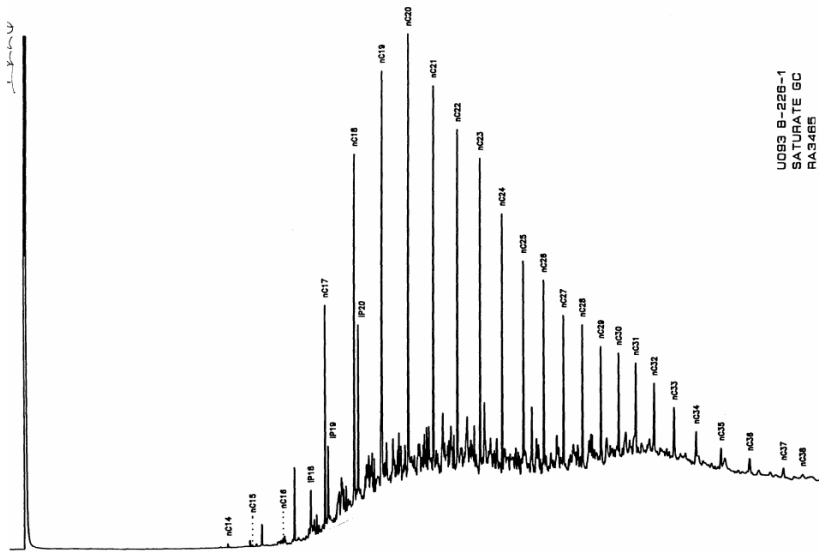


**Wells with high  $S_o$ , but not economically viable by primary and secondary recovery techniques**

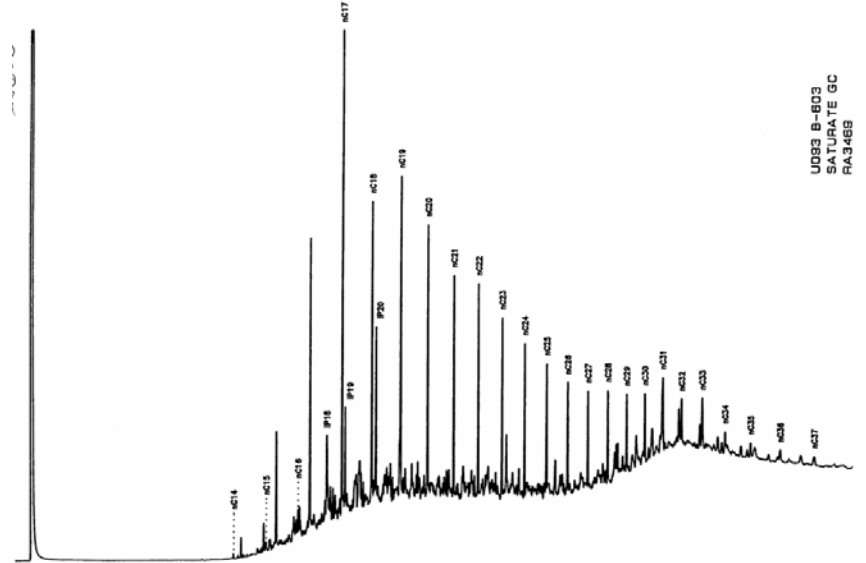
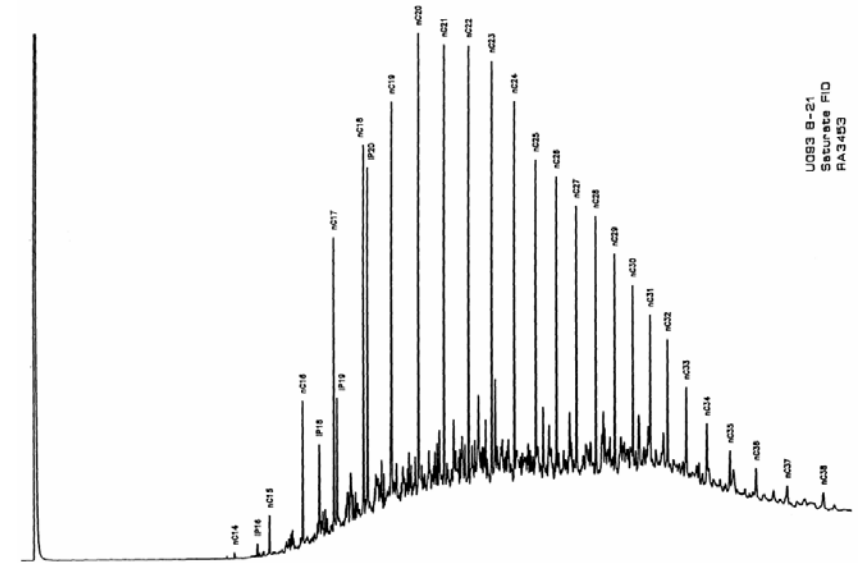


# Oil Properties are Similar in TZ/ROZ and MPZ

## Reservoir Oil



## From Non-productive Wells



# EORI Tensleep Consortium

- Identify interested partners
- Define program objectives
- Identify fields to be evaluated
- Generate project plan
- Develop an interdisciplinary team from EORI and partners
- Evaluate progress periodically



# Technical Challenges

- Reservoir characterization
- Evaluation and modeling of natural fracturing
- Flood design



# Artist's rendition of the new UW Energy Research Center



# EORI Contact Information

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