New Developments in Mature Fields and CO_2 Flooding

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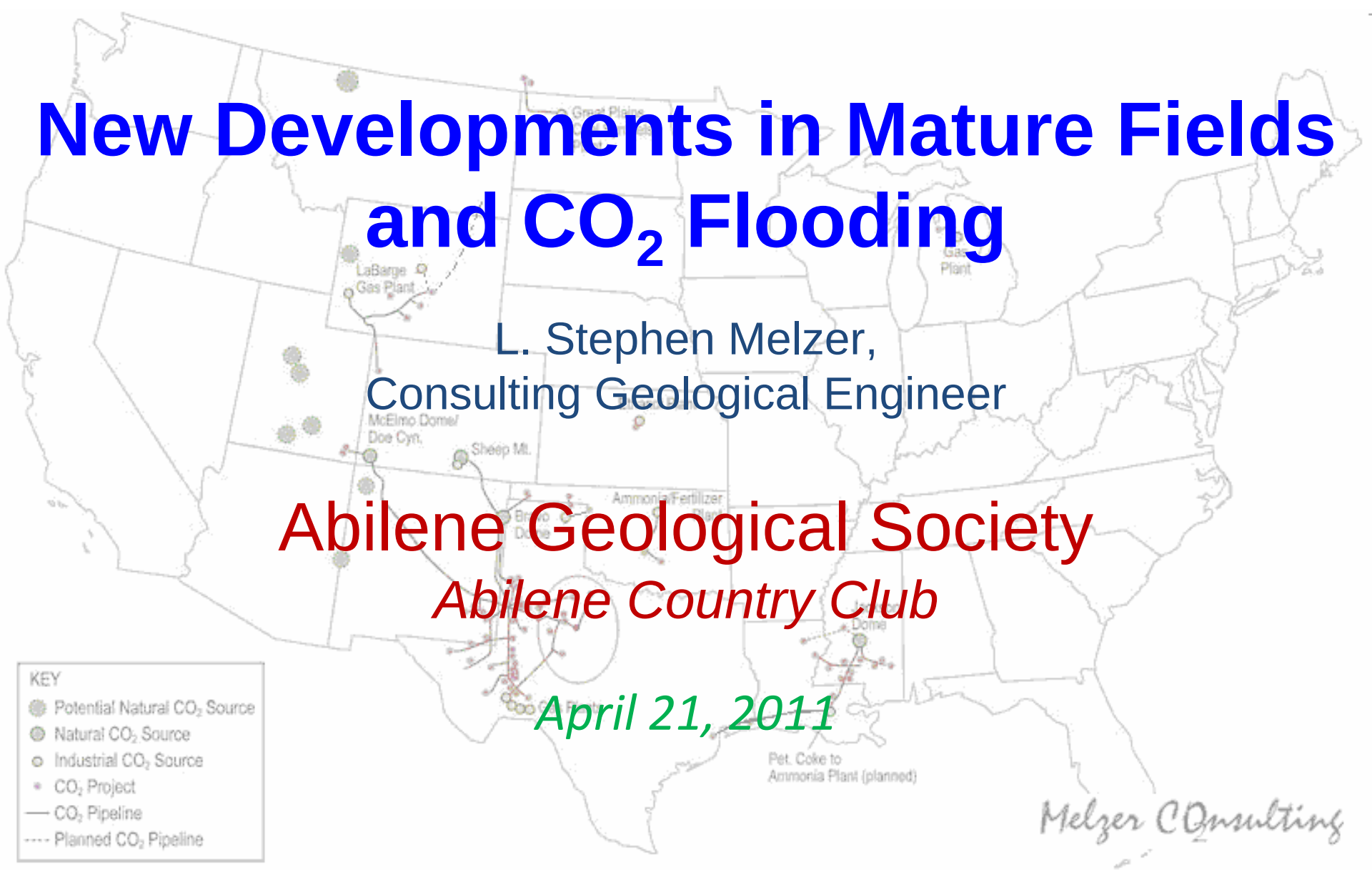

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PRESENTATION OUTLINE

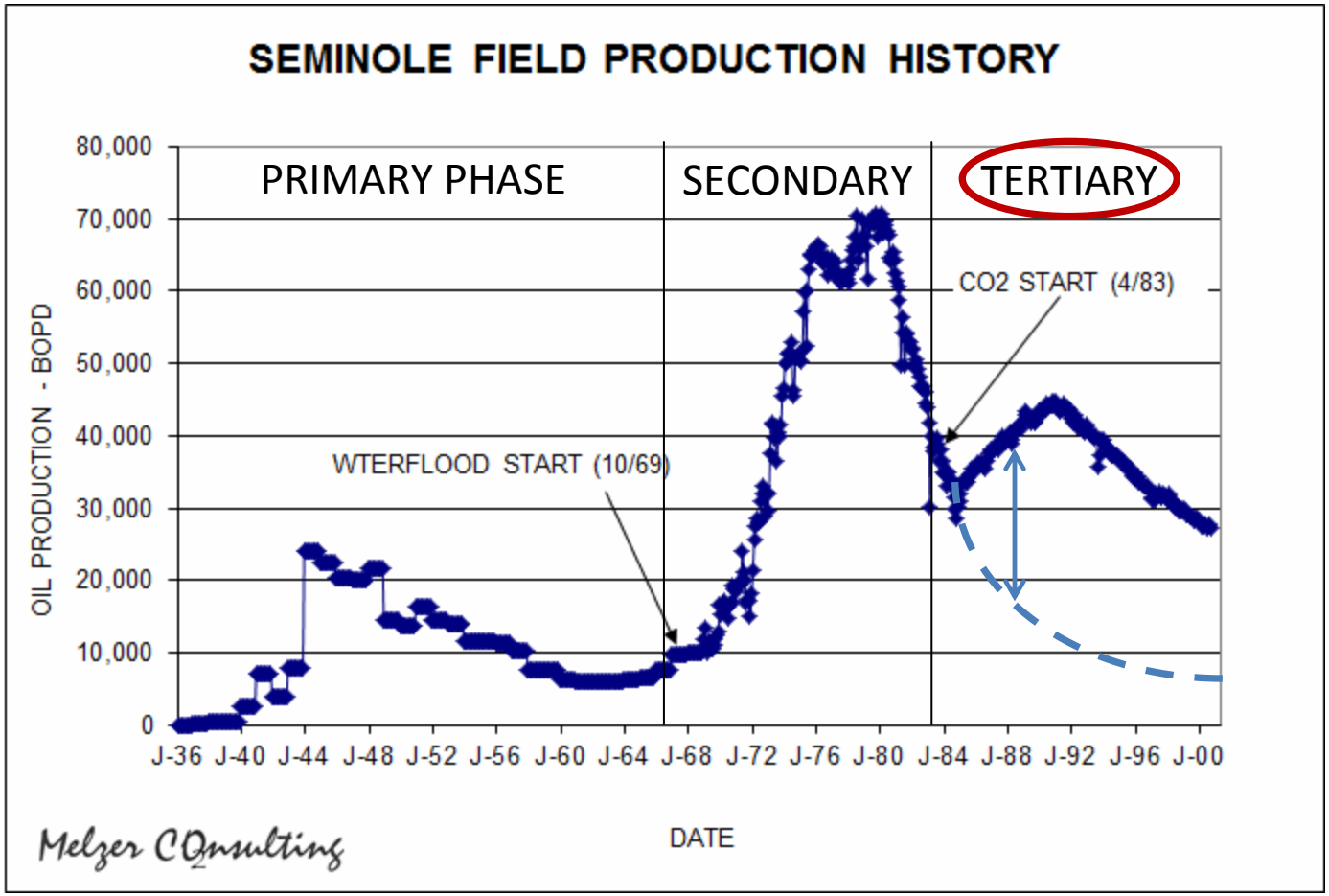
- A Quick History and Status of CO_2 EOR
- The Actual and Pending Spread of CO_2 to the Eastern Shelf
- A New Frontier: Residual Oil Zones
  - The Science
  - Industry Projects: The Engineering
  - The Anecdotal Evidence of ROZs
- Carbon Capture and Storage
- On-going Studies/Research
- Area Wide Study and Need for Your Assistance

Mature Oilfield Developments

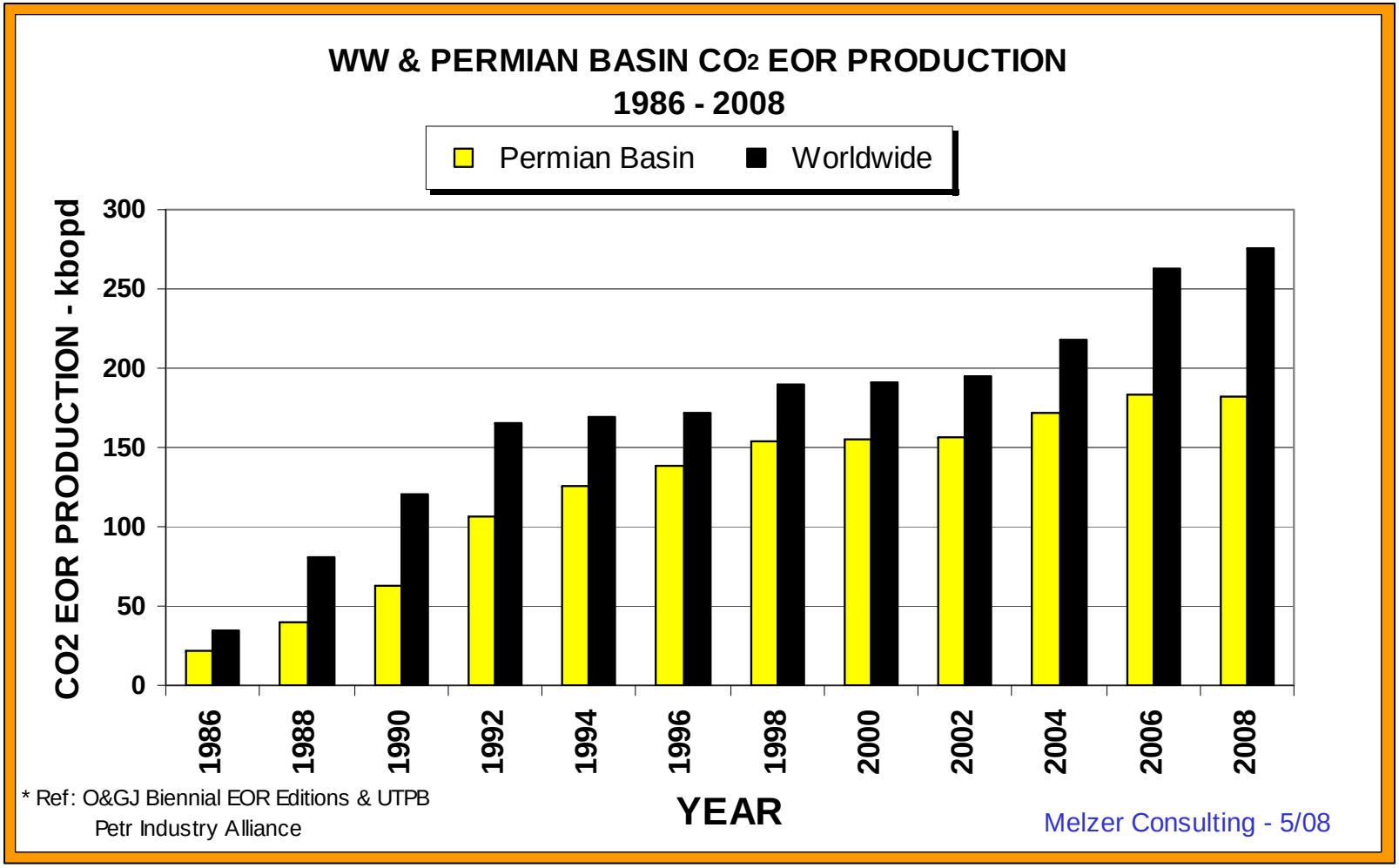
And the Permian Basin's Leadership Role

THE PHASES OF PRODUCTION

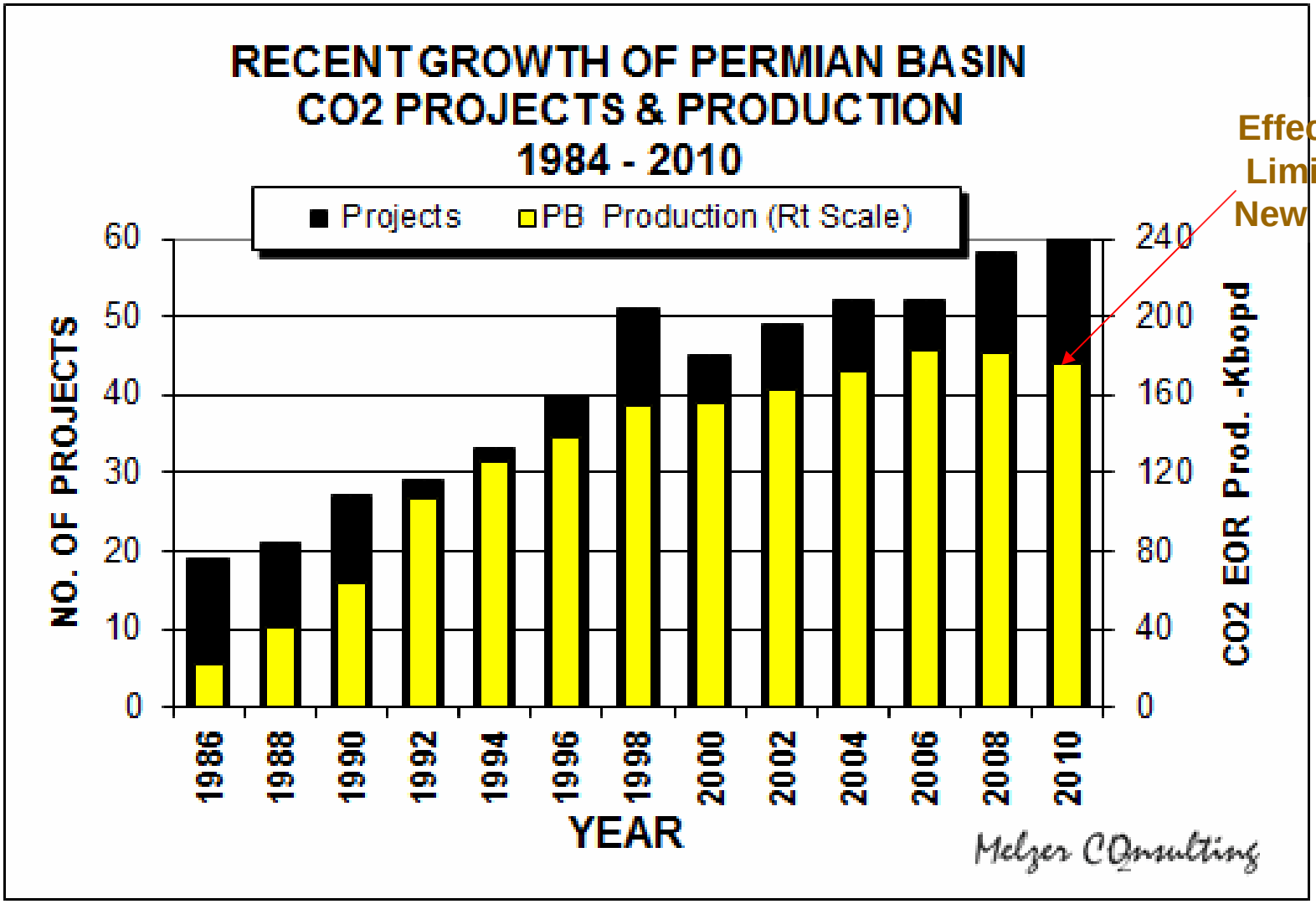
(SEMINOLE FIELD, GAINES COUNTY, TX)



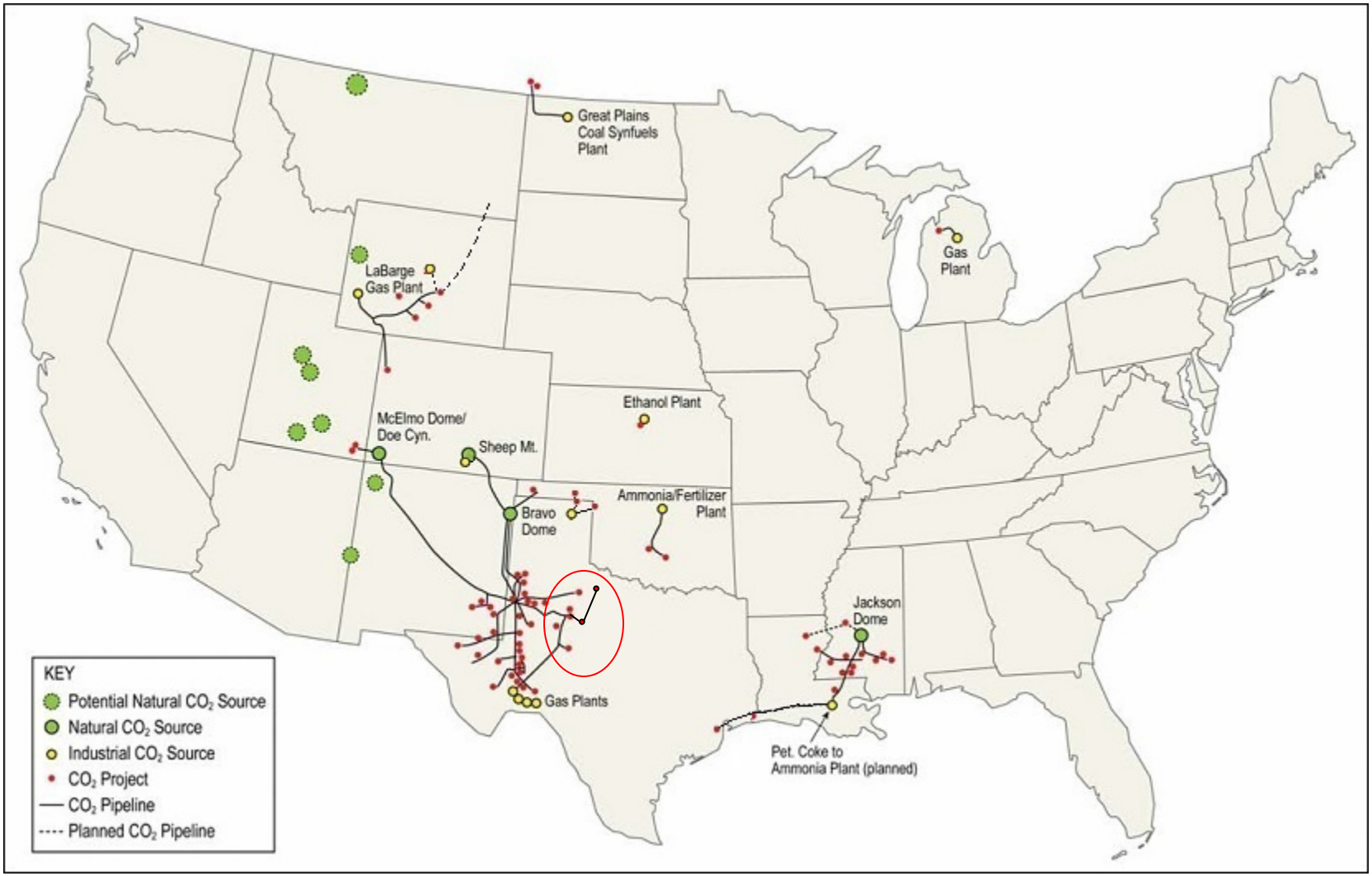
PERMIAN BASIN AND WORLDWIDE CO_2 EOR PRODUCTION



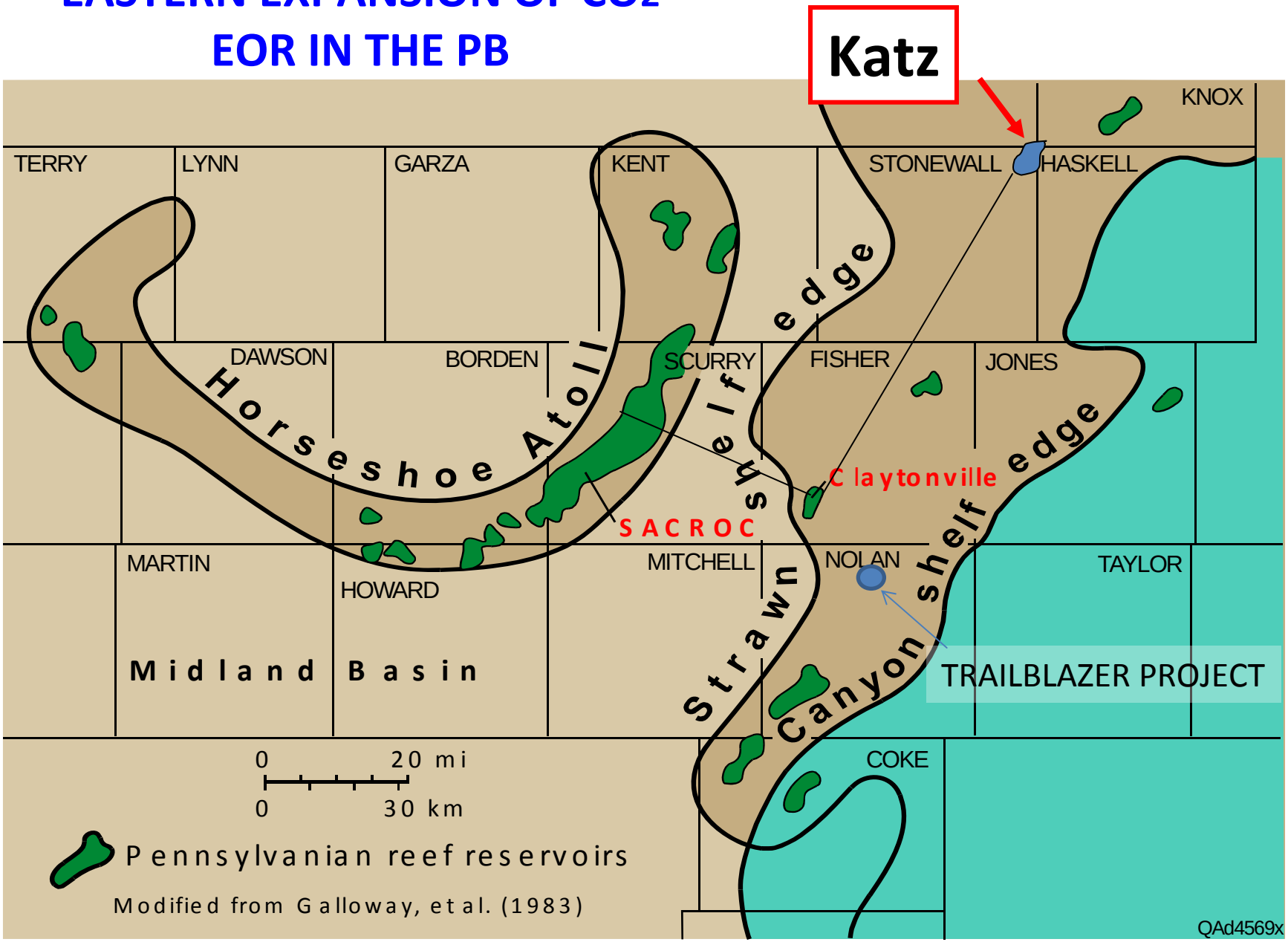
THE EFFECT OF MATURING PROJECTS AND LIMITED NEW SOURCES



The CO_2 EOR Infrastructure



EASTERN EXPANSION OF CO_2 EOR IN THE PB



KINDER MORGAN

Katz Field History

Jan. 1951	Katz Field discovered by Katz Oil Co, H.D. Dozier No. 1 (current well name, ERU No.59).
Mar. 1951	Katz (5100) Field discovered by T.D. Humphrey, Mattie Davis No. 1 (located on the Orsborn Unit).
Jul. 1983	Katz (Day) Field discovered by Getty Oil Co, Roy Day No. 4 (current well name, SWRU No.35).
Oct. 1984	Orsborn Unit waterflood began into the Katz and Katz (5100) Fields (Conoco, operator).
Oct. 1987	ERU unitized in the Katz and Katz (5100) Fields (Standard Oil Production Co, operator).
Nov. 1989	SWRU unitized in the Katz, Katz (Day), Katz (5100) Fields (BP Exploration, operator).
Nov. 1989	CBLU unitized in the Katz and Katz (5100) Fields (Phillips Pet. Co, operator).
May 2006	Kinder Morgan Production Co. became operator of ERU, CBLU, and SWRU.
Nov 2009	Consolidated 3 fields into the Katz (Strawn) Field.

KINDER MORGAN

EOR IN RESIDUAL OIL ZONES

A NEW FRONTIER

Thanks Should Go To….

- Our Funding Agencies: The Research Partnership to Secure Energy for America and the National Energy Technology Lab/U.S. Department of Energy
- The ROZ Team Led at the Univ. of Tx of the Permian Basin
  (Co-principle investigators: L. Stephen Melzer and Dr. Robert Trentham {UTPB})
  - Our Industry Partners:
    - Legado Resources and Chevron
  - Our Subcontractors
    - Arcadis - David Vance, Steve Tischer
    - Advanced Resources International
  - Key Team Members
    - Dr. Martin Cassidy (U of Houston)
    - Phil Eager, Edith Stanton, Saswati Chakraborty
    - Hoxie Smith (Midland College)
    - Bill Lemay (Retired Director, NMOCD and former Consultant)

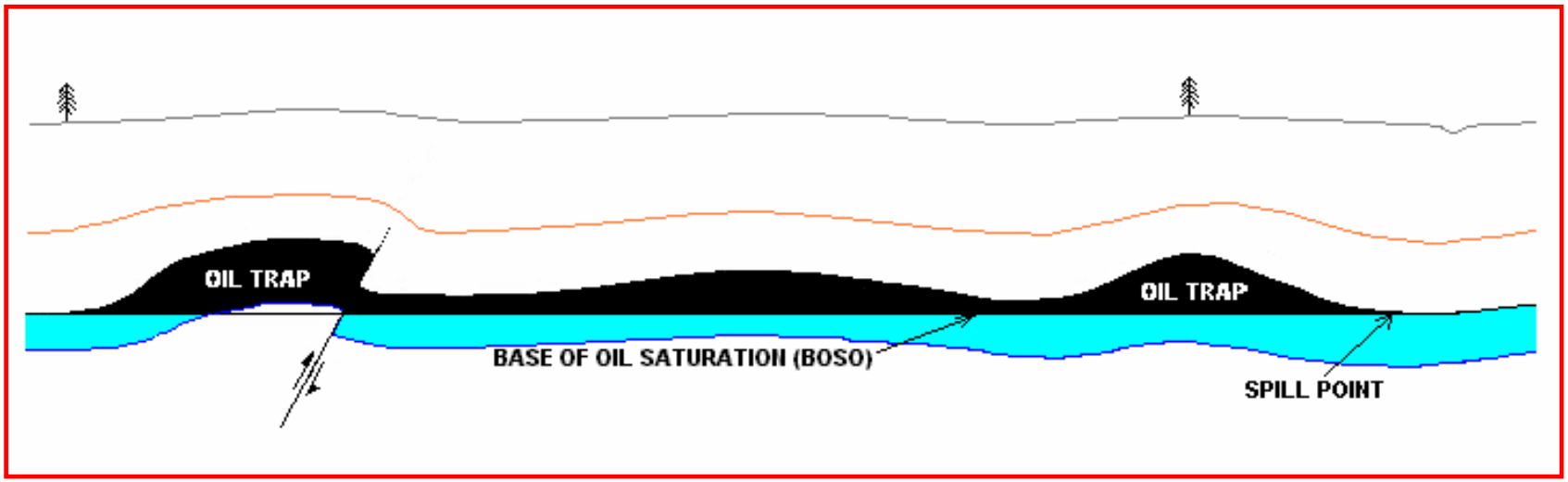
And Also Thanks Go To:

- All those who have battled with the Frustrations of Transition Zones and ROZ's in the past

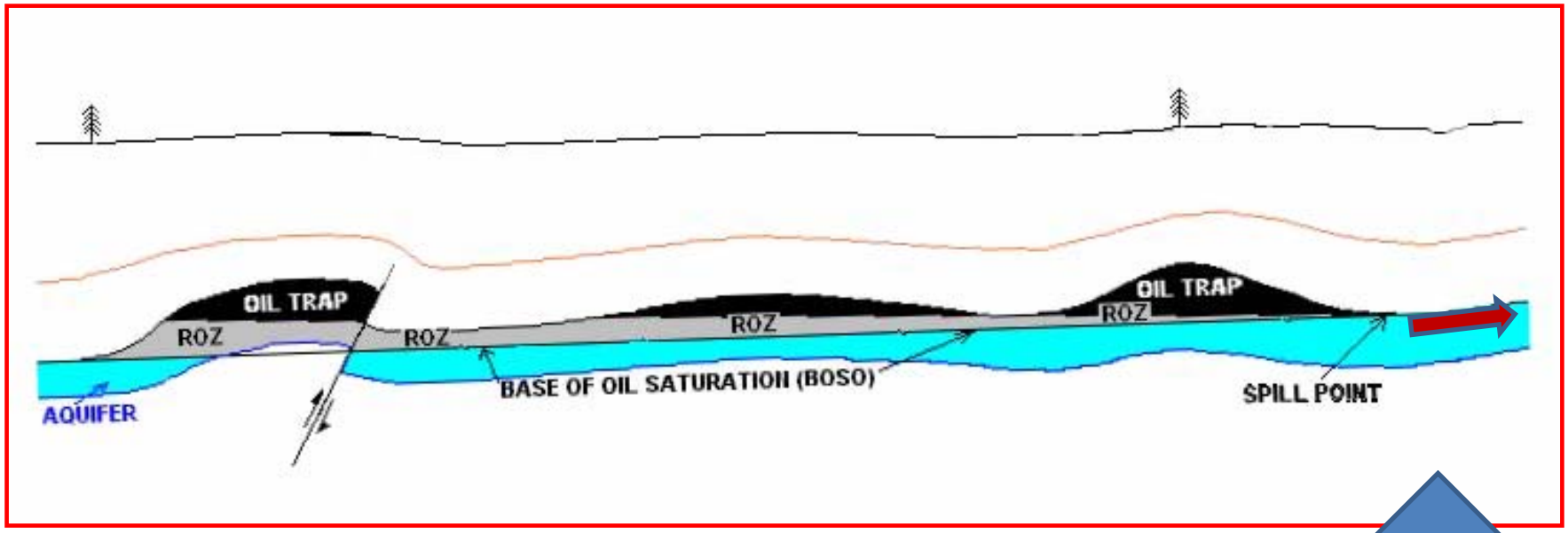
RESIDUAL OIL ZONES: BACKGROUND

- Requires Two Stages of Tectonics
  - Subsidence and Entrapment Stage
  - Second Stage Somehow Altering Existing Traps
- Types of ROZs
  - Type 1: Regional Basin Tilt
  - Type 2: Breached and Reformed Seal
  - Type 3: Lateral Hydrodynamic Flushing

Original Oil Accumulation Under Static Aquifer Conditions (A Hypothetical Example)

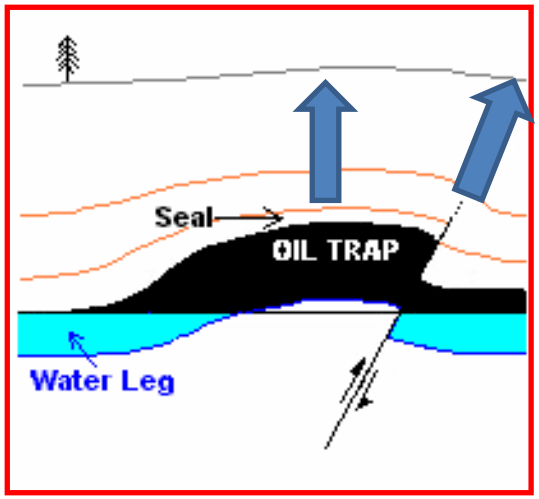


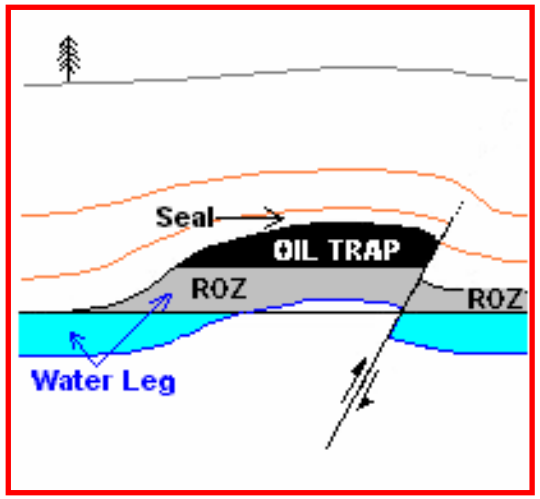
Original Accumulation Subject to a Eastward Regional Tilt & Forming a ROZ. The O/W Contact Is Horizontal, the Base of the ROZ Is Tilted. Oil Would Have Migrated Out of the Basin.



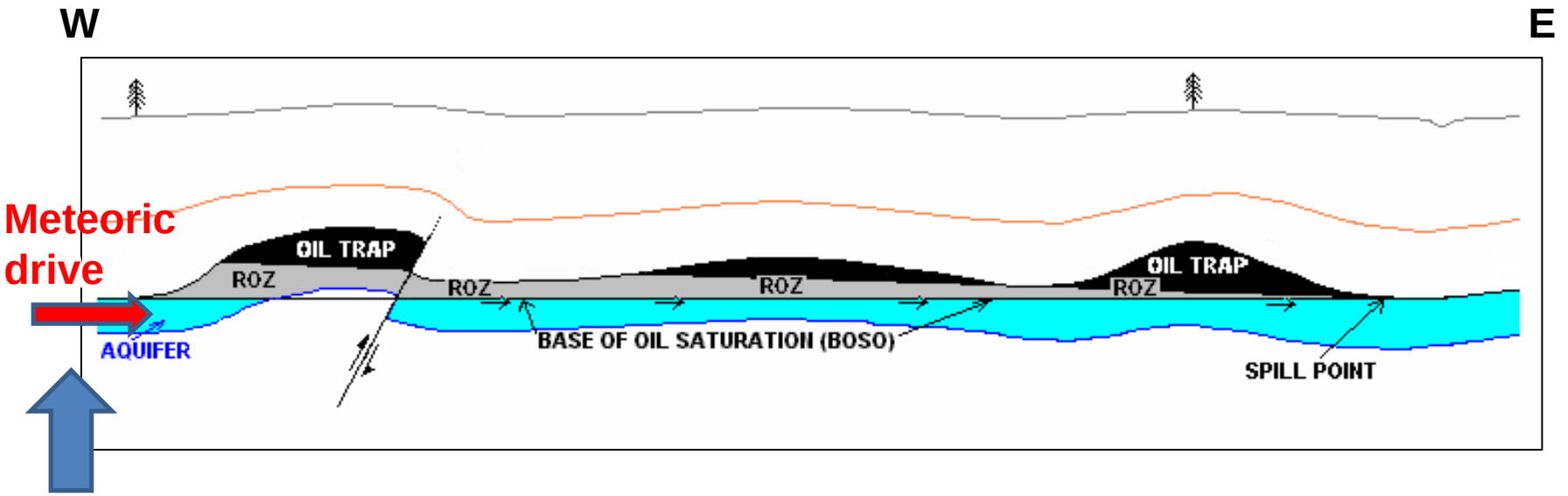
TILT

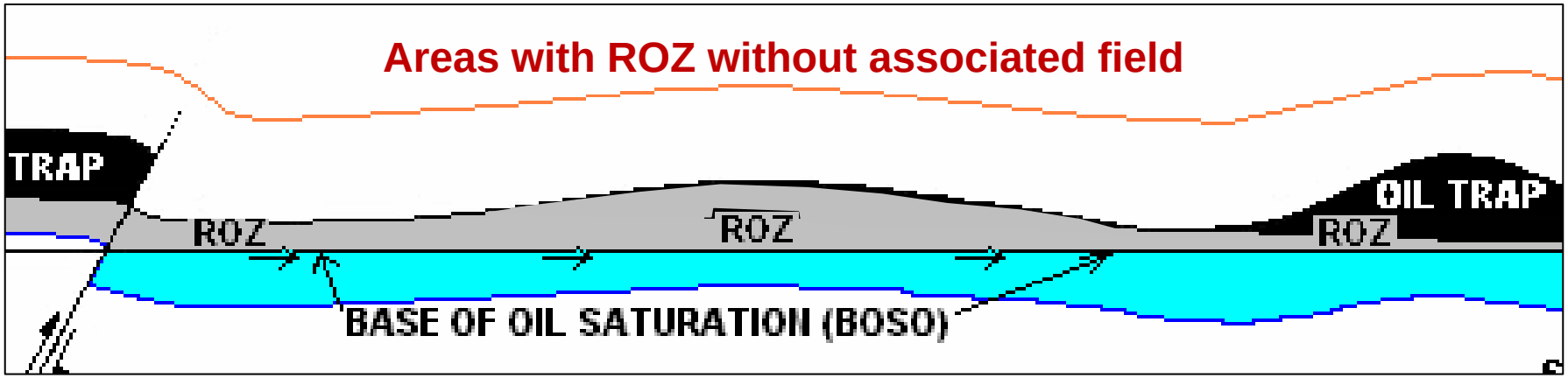
Original Accumulation with a Breached, Reformed, Seal, forming a ROZ, a Horizontal O/W Contact on the Main Pay and the ROZ. May also "de-gas" the Reservoir. Examples Present in the Permian Basin.





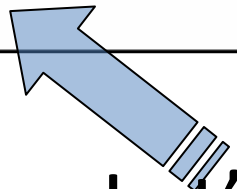
Change in Hydrodynamic Conditions, Sweep of the Lower Oil Column, Oil/Water Contact Tilt, and Development of a Residual Oil Zone. In the Permian Basin, Meteoric Flow is from the West: Rio Grande Uplift.



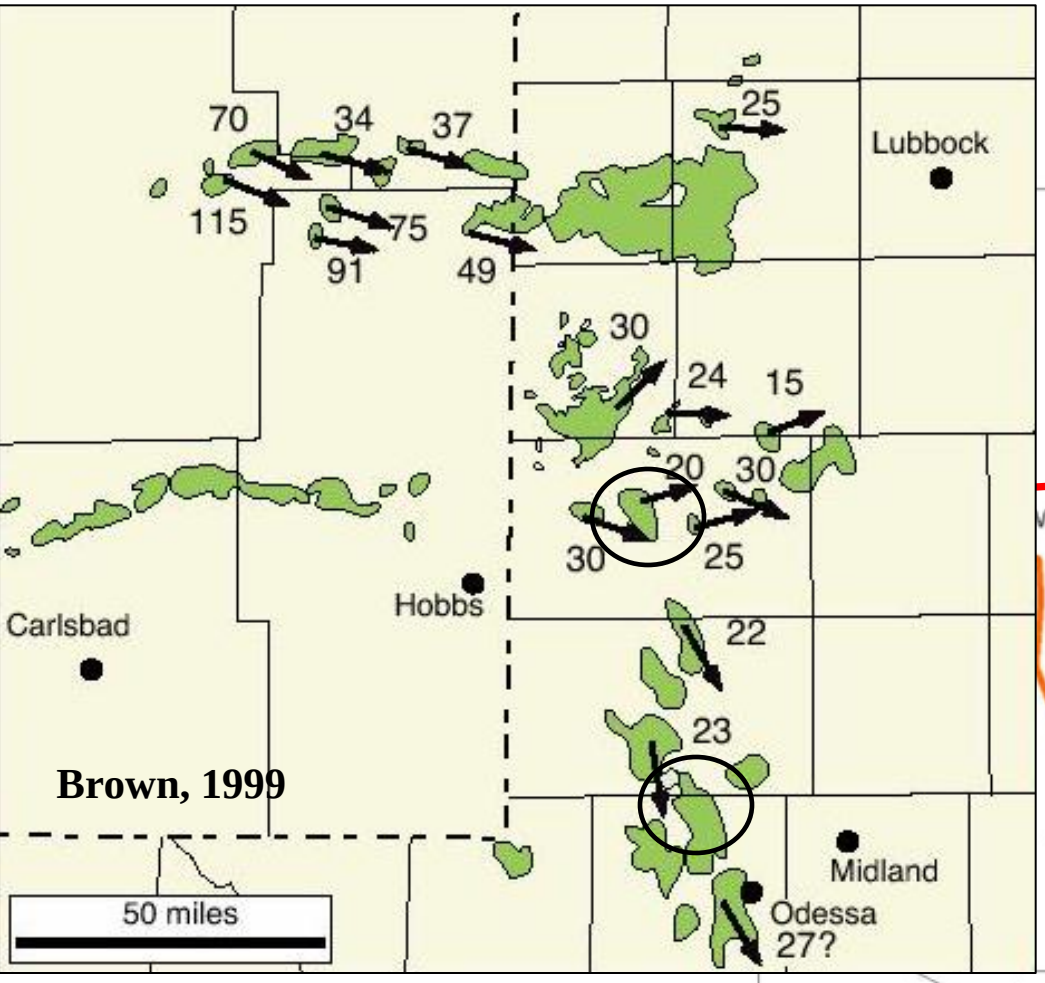


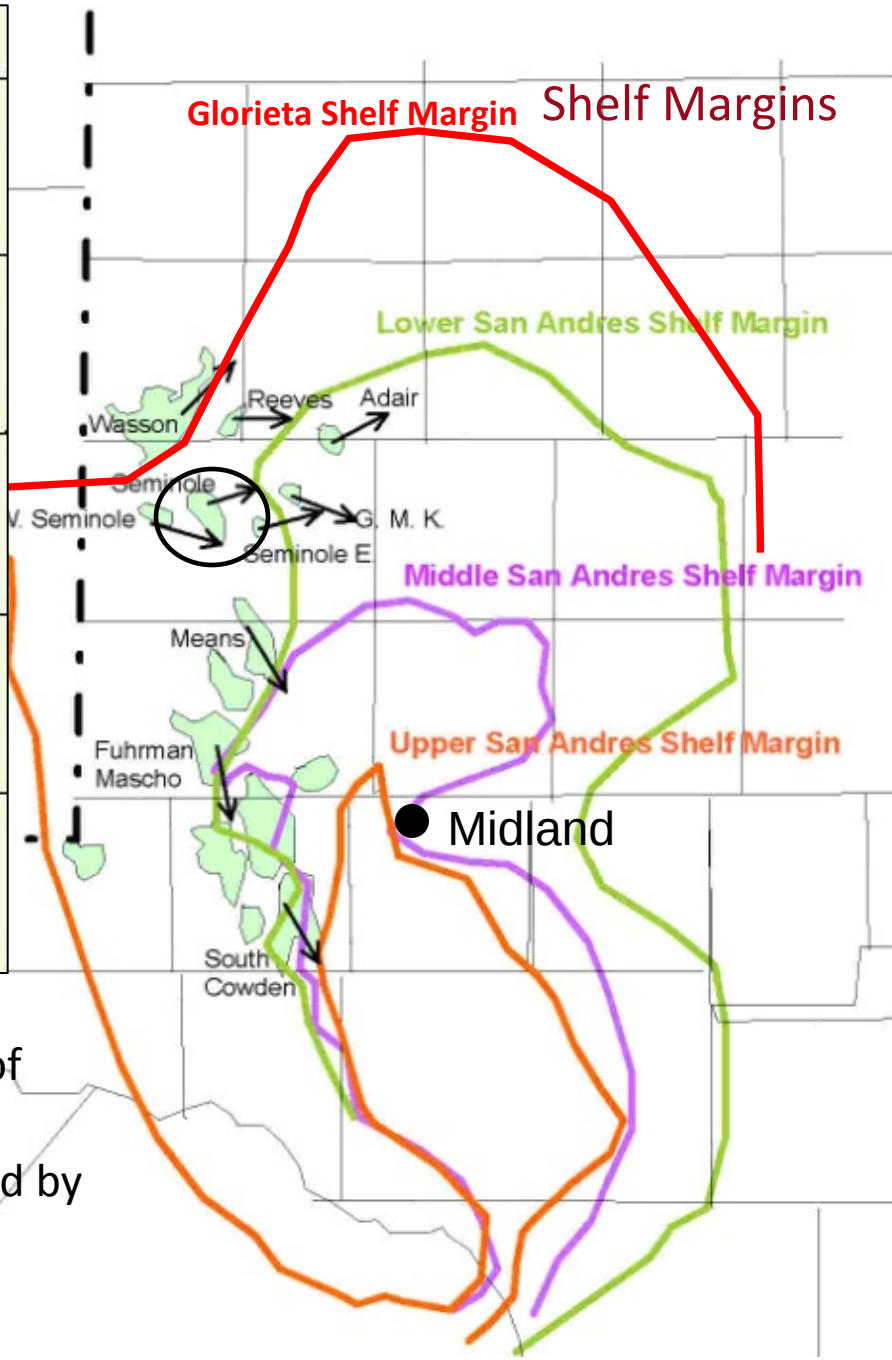
Attributes of the ROZ Types

ROZ TYPE	Oil-Water Contact	Base of Oil Saturation	Other Characteristics
Regional Tilt (1)	Horizontal	Tilted	Wedge with thin side Downdip
Breached Seal and Reaccumulation (2)	Horizontal	Horizontal	Stratified Tar Mats, Anomolously Low GOR
Hydrodynamic Tilt (3)	Tilted	Horizontal	Wedge with thin side in Direction of Flow (to Spill Point)



Let's Look for "anecdotal" Evidence: OWC Tilt





Distribution of Tilted Oil-Water Contacts in the Northern Shelf and Central Basin Platform Areas of the Permian Basin*

The direction of OWC tilt may be influenced by the age of the producing interval and it's relationship to the shelf margin

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Interesting Science but….

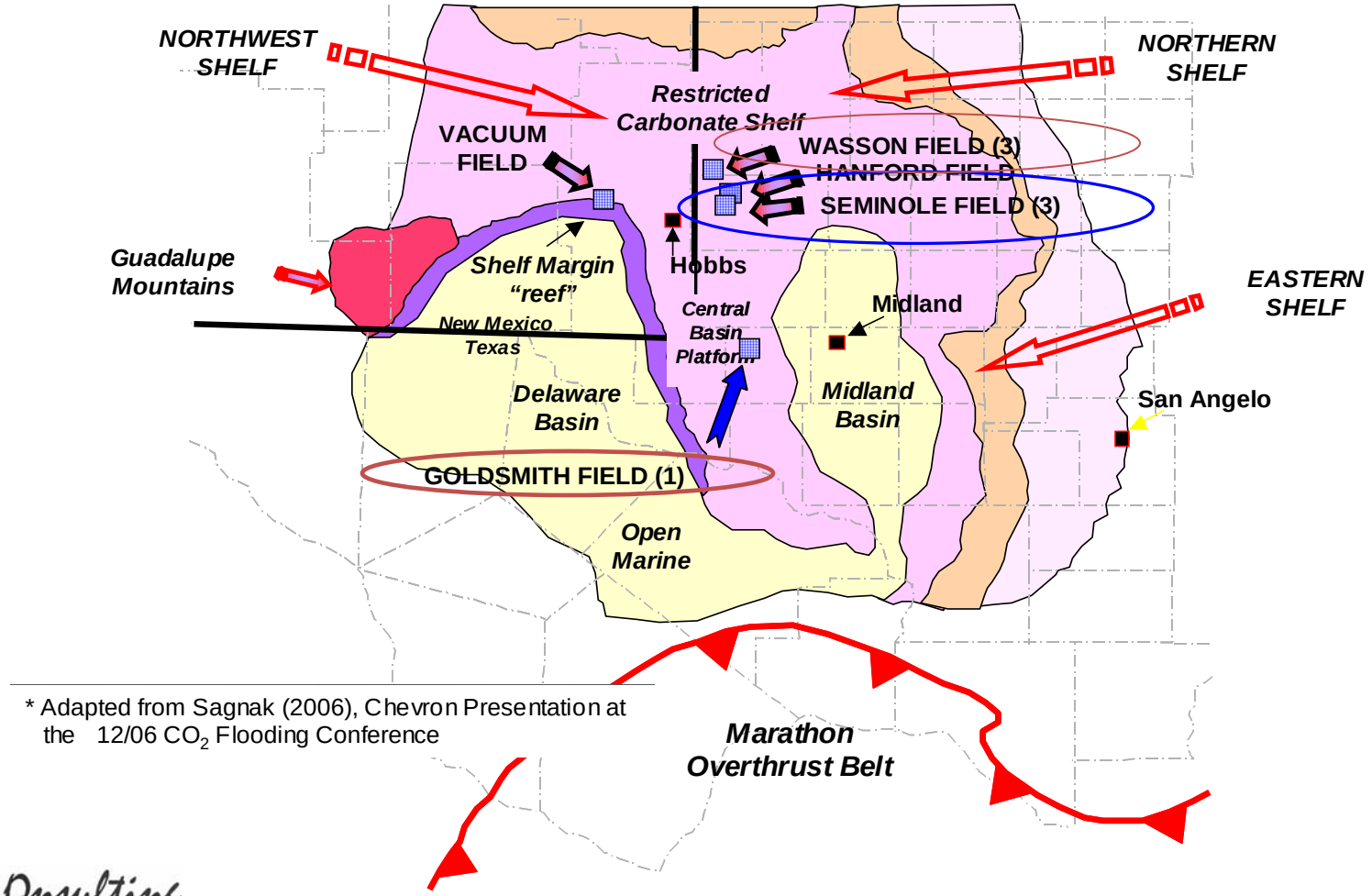
Can We Make Money on the Oil in the ROZ?

COMMERCIALIZING THE ROZ

ACTIVE RESIDUAL OIL ZONE CO_2 EOR PROJECTS IN THE PERMIAN BASIN

MIDDLE SAN ANDRES PALEOGEOGRAPHY

with Location of Industry Documented ROZ Zones/Fields*



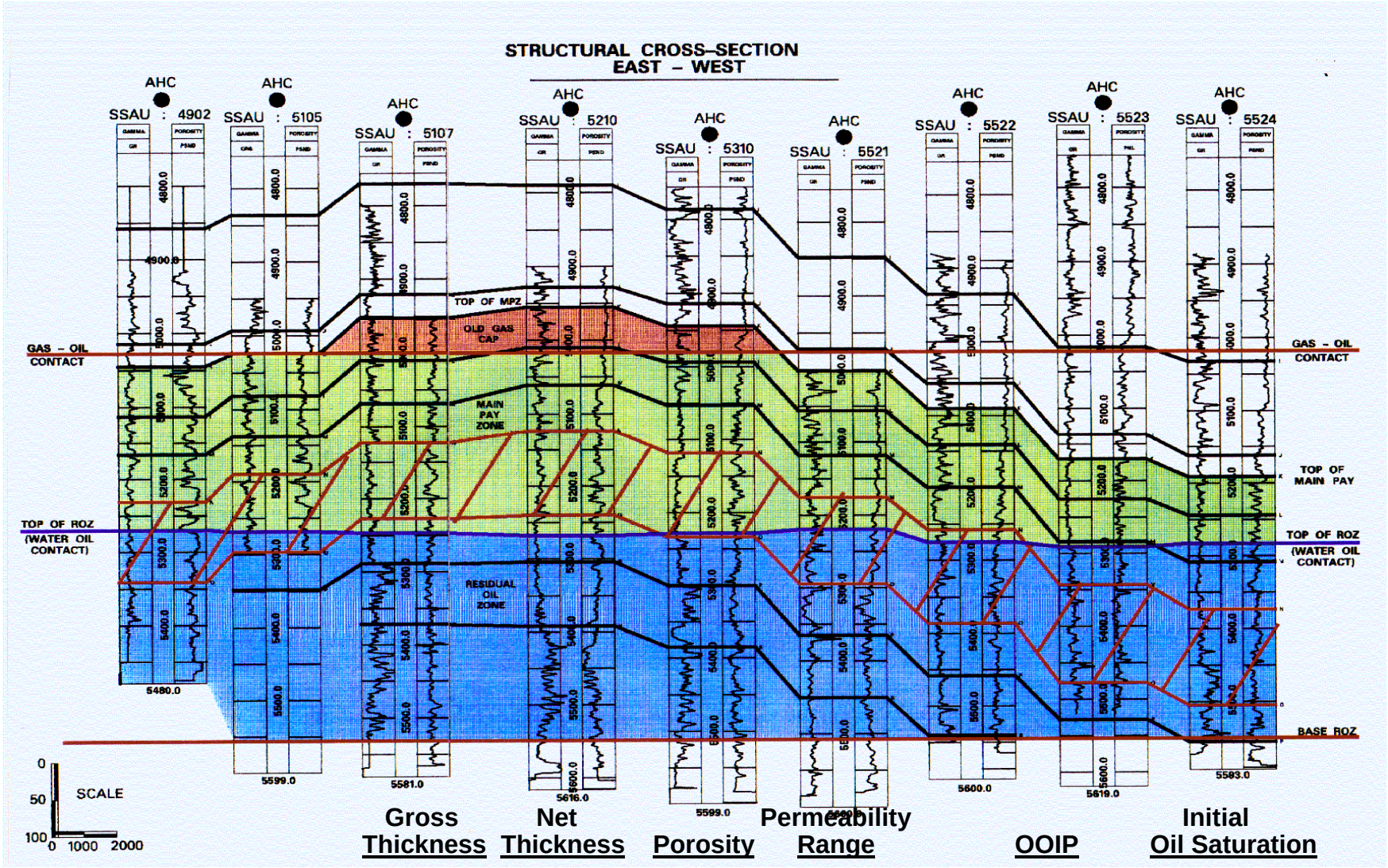
* Adapted from Sagnak (2006), Chevron Presentation at the 12/06 CO_2 Flooding Conference

Active ROZ Floods in the Permian Basin

Highlighted ones have some public exposure

Type and operator	Field	State	County	Top MPZ Depth, ft	Pay zone
Active CO_2 miscible					
Chevron	Vacuum San Andres Grayburg Unit	NM	Lea Co.	4,550	San Andres/Grayburg
Fasken	Hanford	Tex.	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Phase 1	Tex.	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Phase 2	Tex.	Gaines	5,500	San Andres
Hess	Seminole Unit-ROZ Stage 1 Full Field Dev	Tex.	Gaines	5,500	San Andres
Legado	Goldsmith-Landreth Unit	Tex.	Ector	4,200	San Andres
Occidental	Wasson Bennett Ranch Unit	Tex.	Yoakum	5,250	San Andres
Occidental	Wasson Denver Unit	Tex.	Yoakum	5,200	San Andres
Occidental	Wasson ODC	Tex.	& Gaines	5,200	San Andres

SSAU MPZ & ROZ Crossection and Zonal Attributes



	Gross Thickness	Net Thickness	Porosity	Permeability Range	OOIP	Initial Oil Saturation
Main Pay Zone (MPZ):	160’	126’	12%	0.8-120 md	1 billion stbo	0.84
Residual Oil Zone (ROZ):	246’	197’	12.6%	0.5-270 md	960 million stbo	0.32

Hess Corporation References from the 2001 and 2008 CO_2 Flooding Conferences

SSAU Background

Ownership

Hess	**34.3% (operator)**
OXY	**28.0%**
ExxonMobil	**19.2 %**
Marathon	**13.5 %**
Chevron	**2.5 %**
Others	**2.5 %**

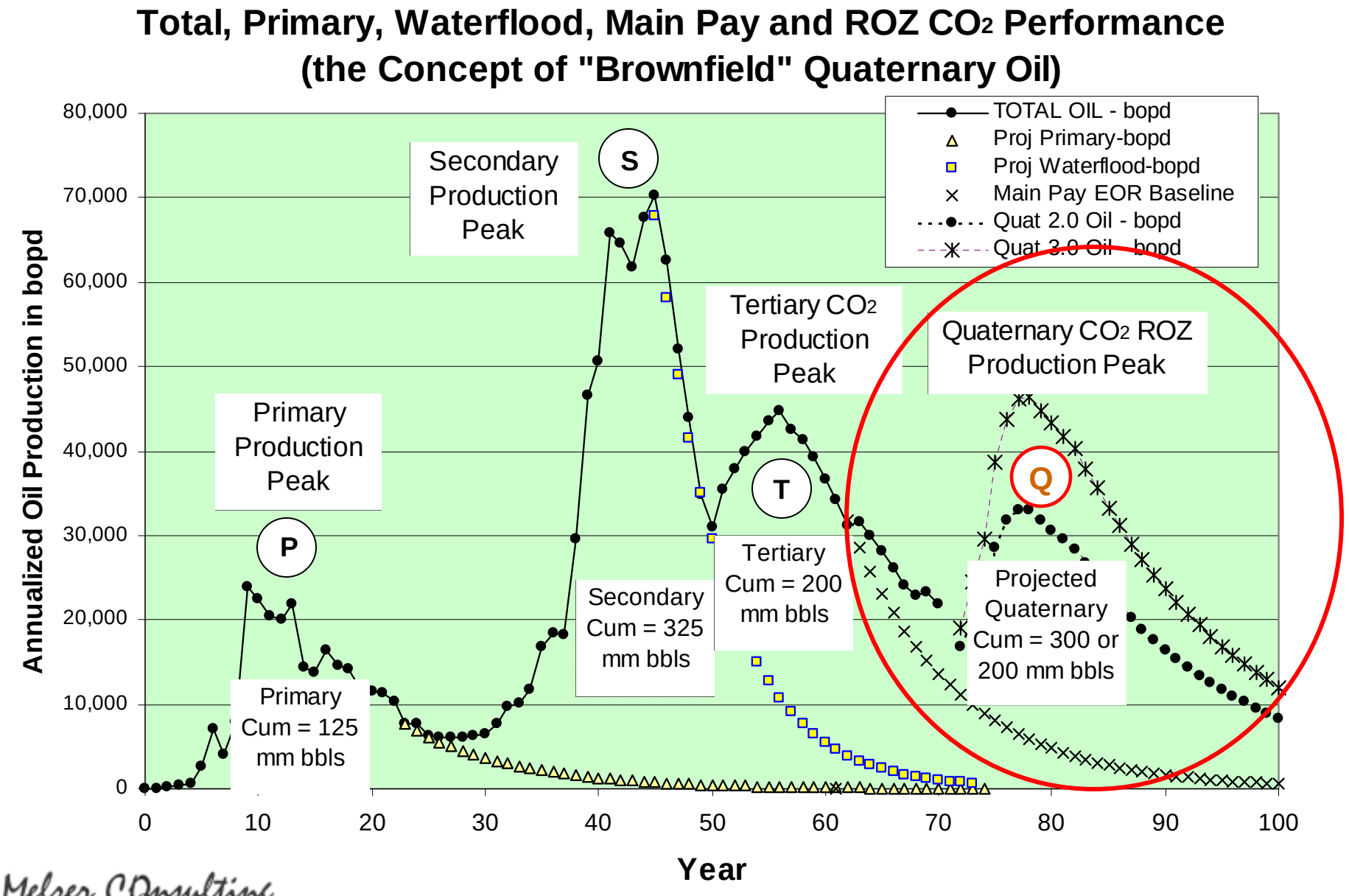
Location: **Permian Basin, TX**

Wells: **396 prod 171 inj**

Facilities: **SSGP Unit CO2 Recovery Plant**

Reservoir Description	**Limestone and dolomite deposited in a shallow carbonate ramp environment**
Fluid Type	**Saturated black oil**
Drive Mechanism	**Gas in solution and gas cap during primary. External energy from water and CO2 injection during secondary and tertiary recovery.**
Develop. History	**1936 Discovery** **1936 First Production** **1969 Unitized/Waterflood** **1983 MPZ CO2 Flood Begins** **1996 ROZ Phase 1** **2004 ROZ Phase 2** **2007 ROZ Stage 1**
Cumulative Production	**675 MMBO, 40 MMBOE NGL, 702 BCF HC Gas**
Current Rate	**19.6 MBOPD, 200 MMCFD CO2+HC** **25,500 MBOEPD (Oil+NGL+Gas)**

‘Quaternary’ Oil at the Seminole Field (Given Access to Needed CO_2 Supplies)



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THE "ANECDOTAL" EVIDENCE

Oil Shows: DSTs, Cuttings, Cores

Water Salinities, Sulfur Water, Sour Oil

Corrosive Zones

Pervasive Zonal Dolomitization

Discharge Paths, Lineaments

Sulfur Deposits

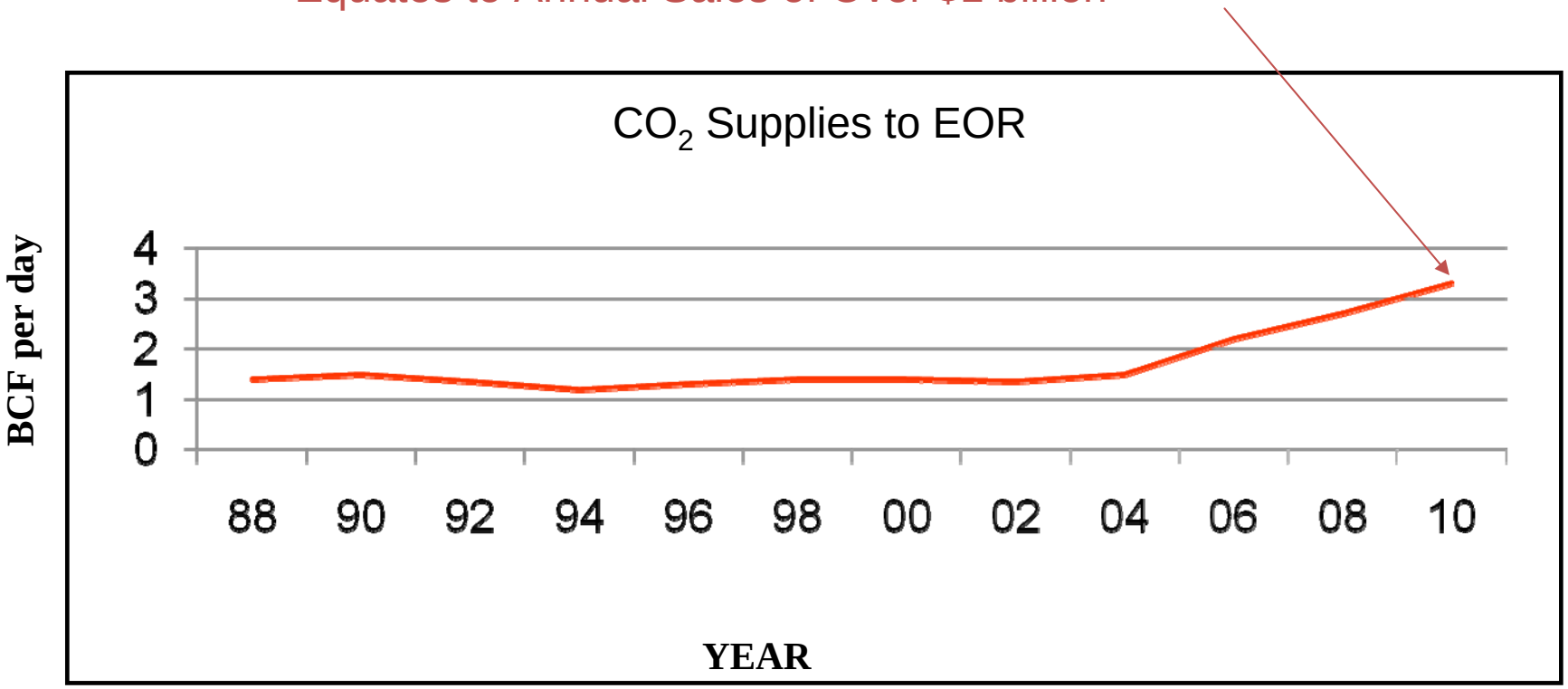
Carbon Capture and Storage

- Defined as Capturing CO_2 Emissions from Industrial Sources and 'Sequestering' the CO_2 in Permanent or Semi-Permanent Storage; e.g., underground, soil, biota, solids, etc.
- CO_2 EOR can Utilize Huge Volumes of CO_2
- In spite of the Recycled Volumes, CO_2 EOR can Effectively Store 99%+ of Injected 'New' CO_2

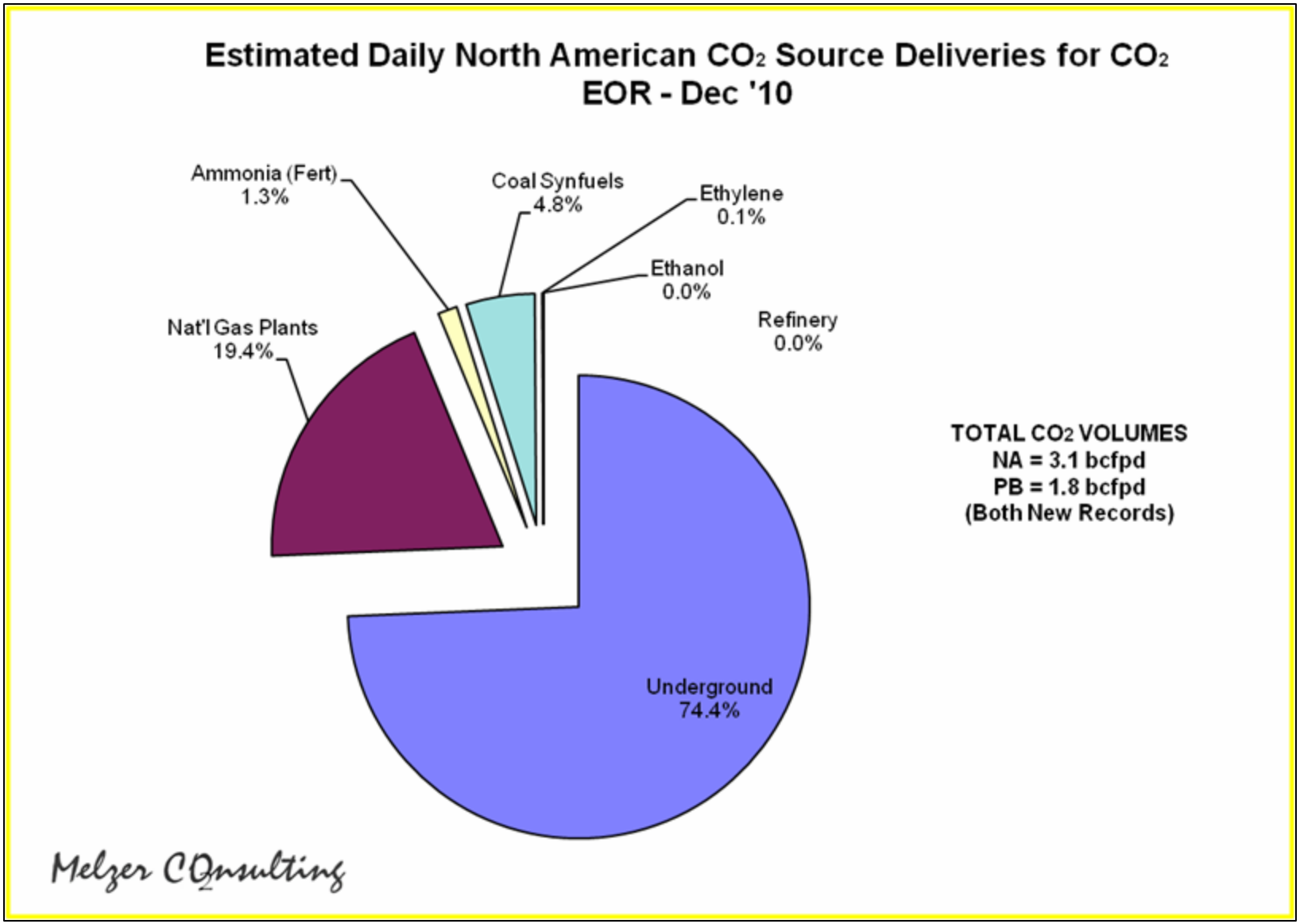
THUS CO_2 EOR HAS THE WIN-WIN SCENARIO OF MORE DOMESTIC OIL AND THE ENVIRONMENTAL BENEFIT OF CCS

U.S. CO_2 SALES FOR EOR

At, say, an Average Price of $1.00/mcf this Volume Equates to Annual Sales of Over $1 billion



Breakout of Natural vs. Industrial by-Product CO_2



ON-GOING STUDIES / RESEARCH

ROZ HISTORY / INITIATIVES

1) EARLY PRIVATE TZ/ROZ* INVESTIGATIONS
   - Private Industry Research
   - UTPB, Melzer Consulting, and ARI** Syntheses
2) 2006 DOE REPORT AND SUBSEQUENT SPE PAPERS
3) RPSEA*** ROZ ORIGINS AND HYROLOGICAL MODELING
4) DOE: ROZ & MPZ CO_2 FLOODING OIL RESPONSE
5) REGIONAL ROZ ORIGINS AND DISTRIBUTIONS (Proposal)

↑ Past Work ↓

↑ On-going ↓

• Transition Zone/Residual Oil Zone

** Advanced Resources International

*** Research Partnership to Secure Energy for America

PRESENTATION CONCLUSIONS (1)

- CO_2 EOR has Slowly Grown to Become Big Business and is Led by the Permian Basin (PB): Producing nearly 200,000 bopd in Over 60 projects While Injecting Nearly 2 bcfpd of New CO_2 in the PB
- CO_2 is Reaching the East Shelf but…..will that continue?
- Growth of CO_2 EOR Has Been Steady – Even in Times of Low Oil Prices
- Growth is Continuing in Main Payzones but ROZs are Replacing Transition Zone Thinking and Are Now Recognized as Huge New Targets

PRESENTATION CONCLUSIONS (2)

- ROZ CO_2 Flooding is Commercial
- PB EOR is CO_2 Short Today – New Sources are Needed
- With all the ROZ Targets to the West, the Eastern Shelf Needs its Own Source(s) of CO_2
- The Trailblazer Project Would Provide a Great Beginning

Thank you!

Time for Questions?