Shale plays--- deep water--- similarities?

SPE Northside Study Group

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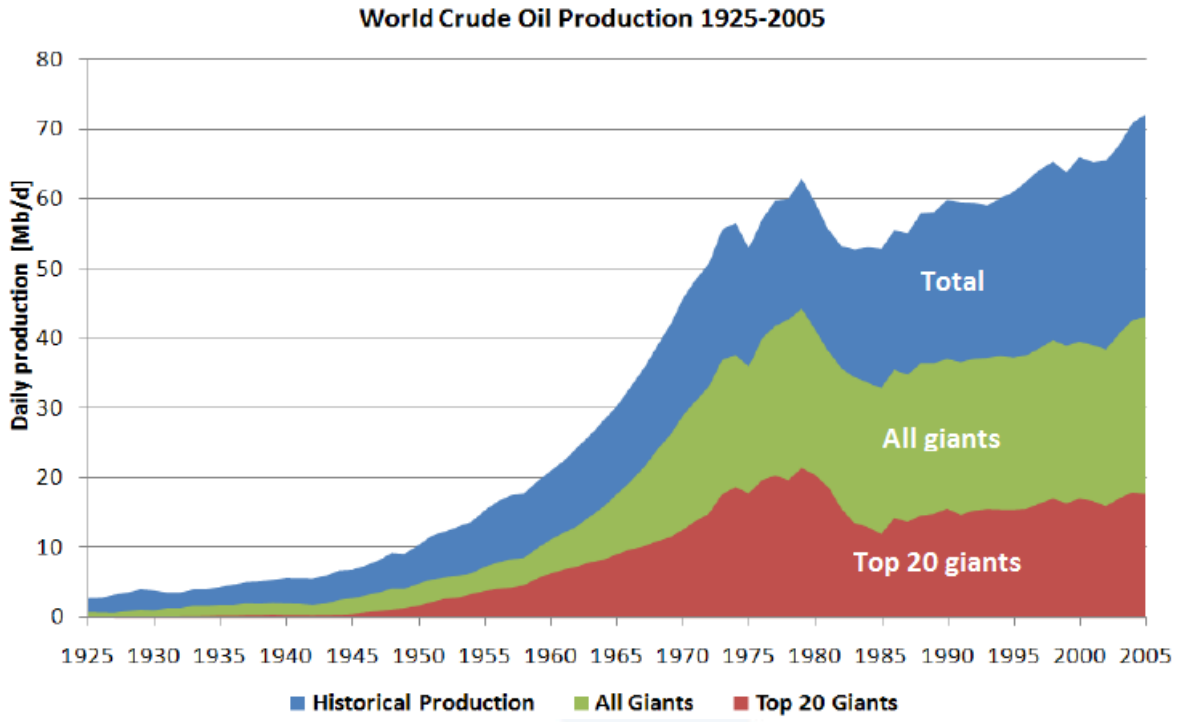
Outline

- **Global Impact**
- Comparison of deepwater and shale plays
- What is a shale, anyway?
- Other technology/service issues

Facts vs. theory

- **“Fact without theory is trivia”**
- **“Theory without facts ...”**
- 60% of the world’s hydrocarbon production comes from 320 of the world’s 17,000+ large oilfields.



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Impact on how we thought

- Models of future oil production including pricing and demand (peak oil) reflected the belief that giant oilfields would be less plentiful and far more costly.
- “we have to find giant fields” meant “we have to go to unexplored regions and depths”
- Unconventional resources generally and shales specifically have injected a very large and as yet not completely quantified increase in supply.
- Have we really moved from scarcity to abundance?
- Impact has been substantial on gas and NGL prices.
- How well will it travel outside North America?
- How sustainable will the impact be?

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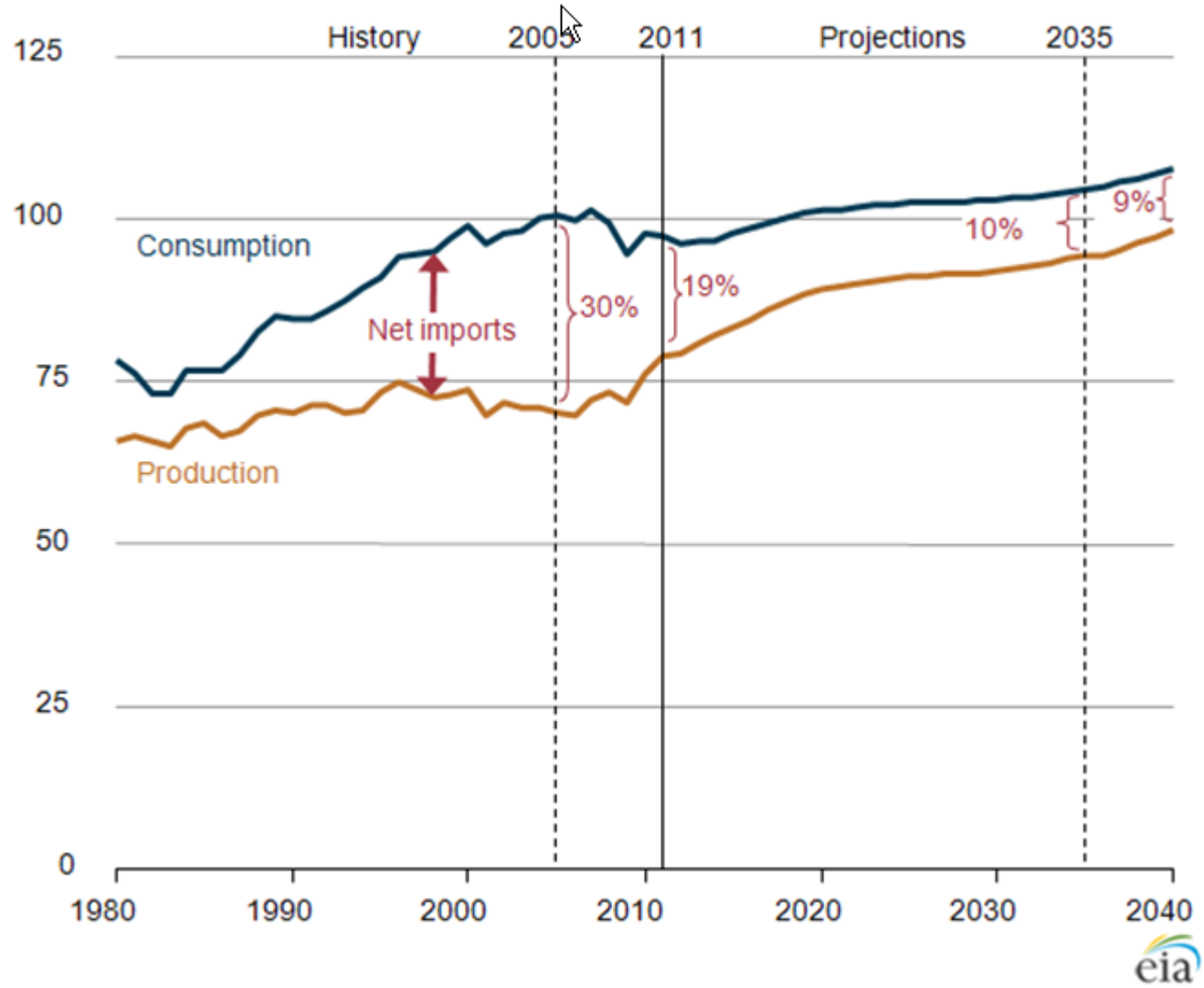
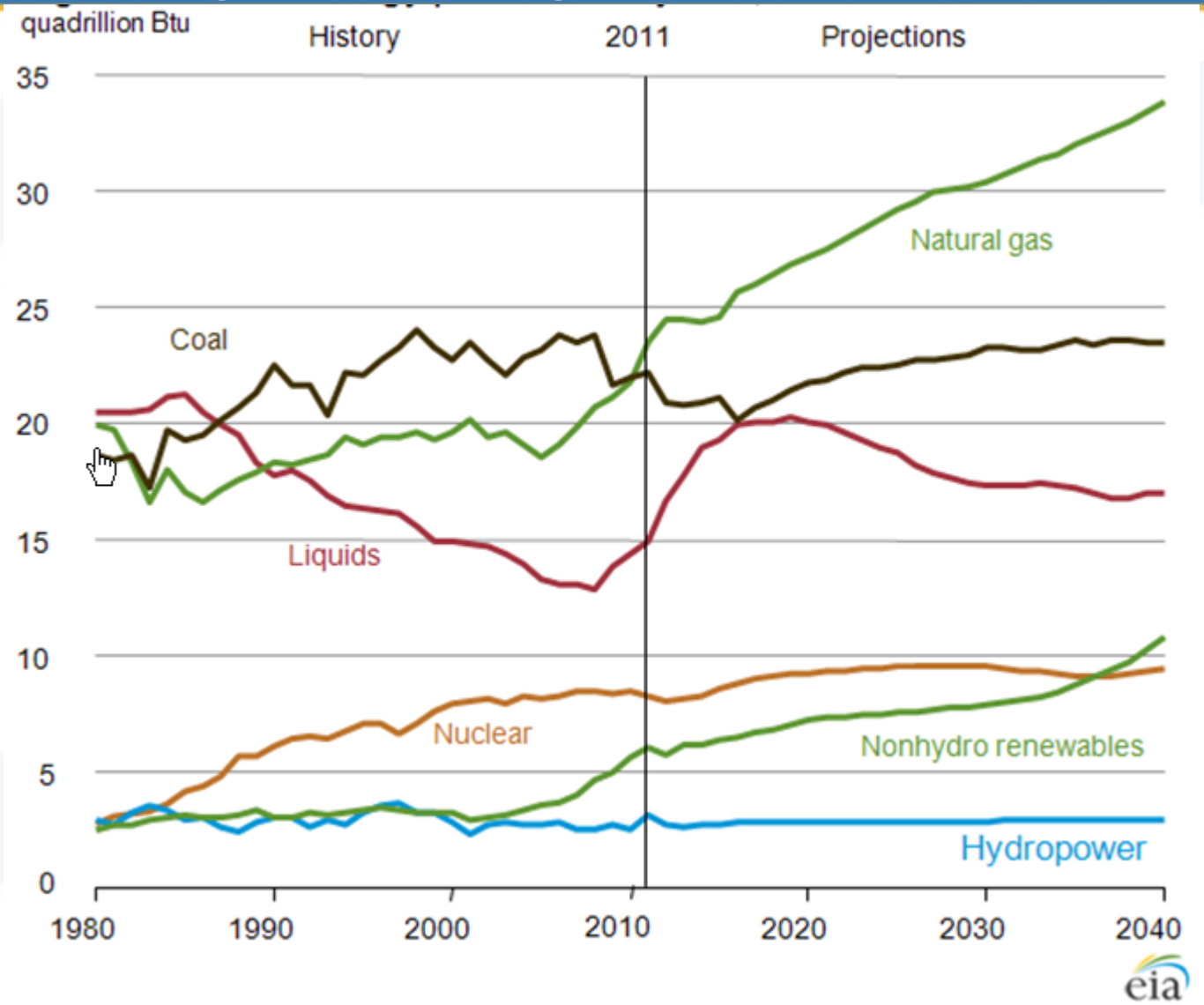
Net imports continue to decline



Impact of UCV is to reverse decline in production and stifle growth in high cost alternatives



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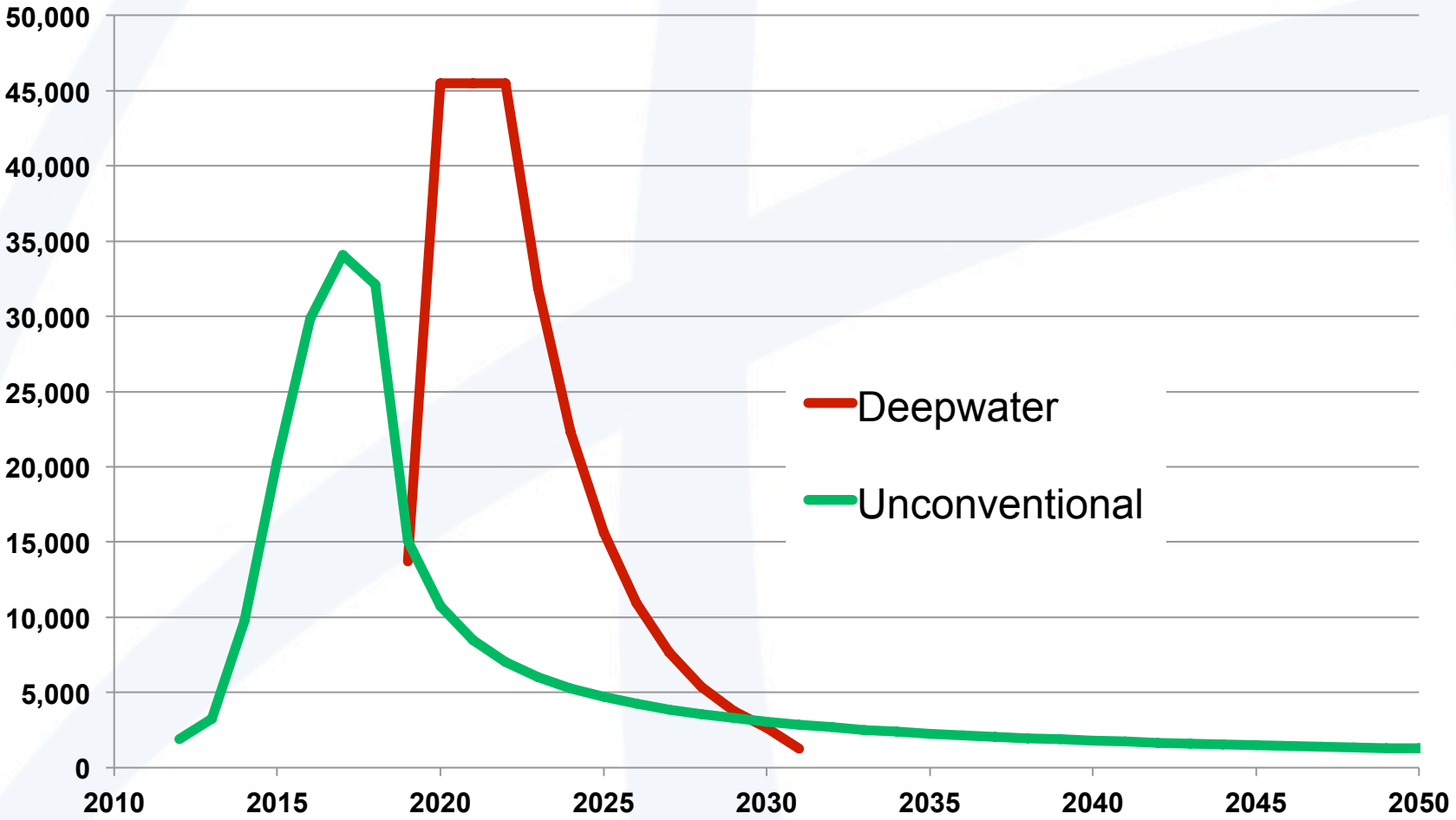
Production Profiles for a 100 MBO project---deepwater and a shale play



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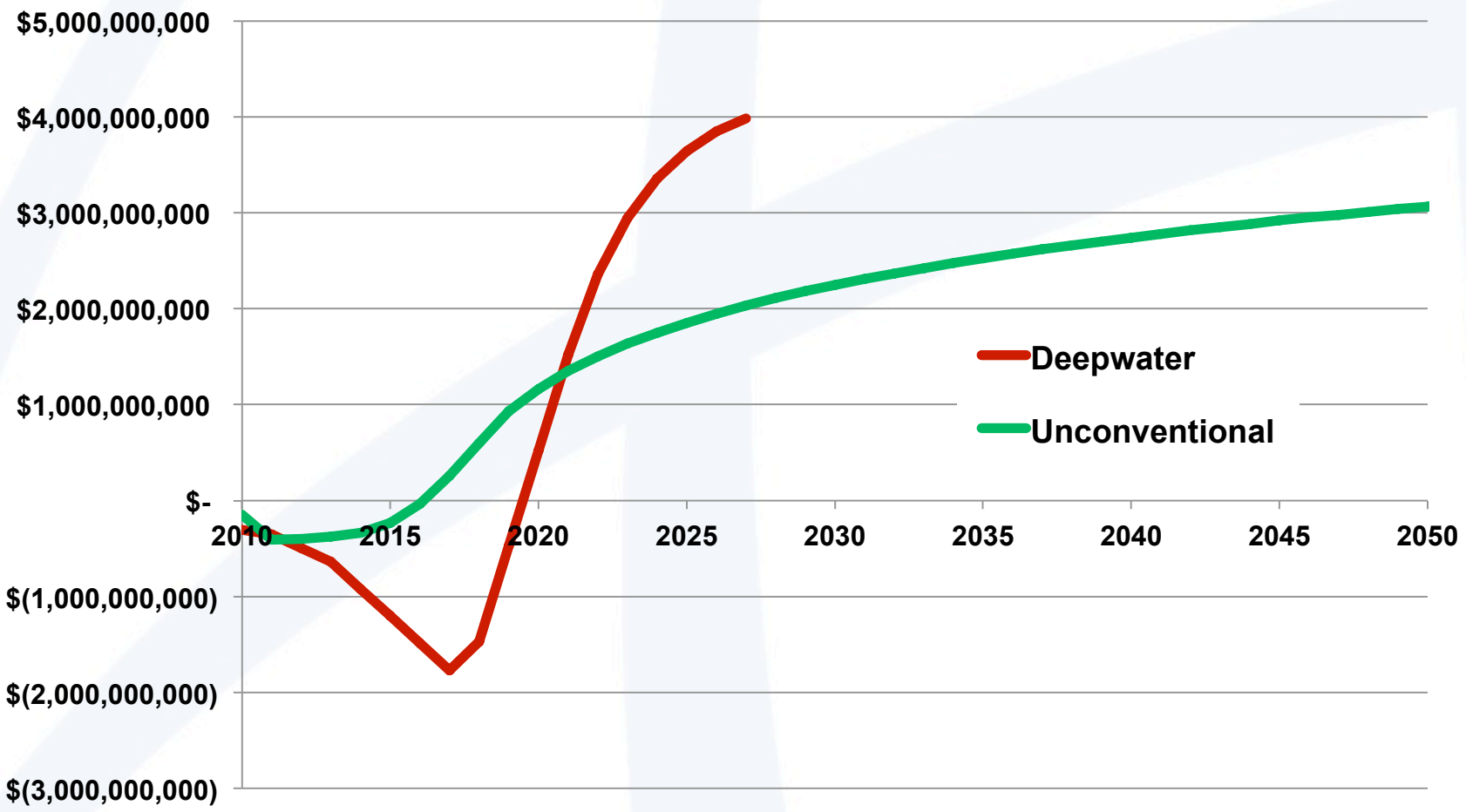
Comparison of cumulative cash flows 100



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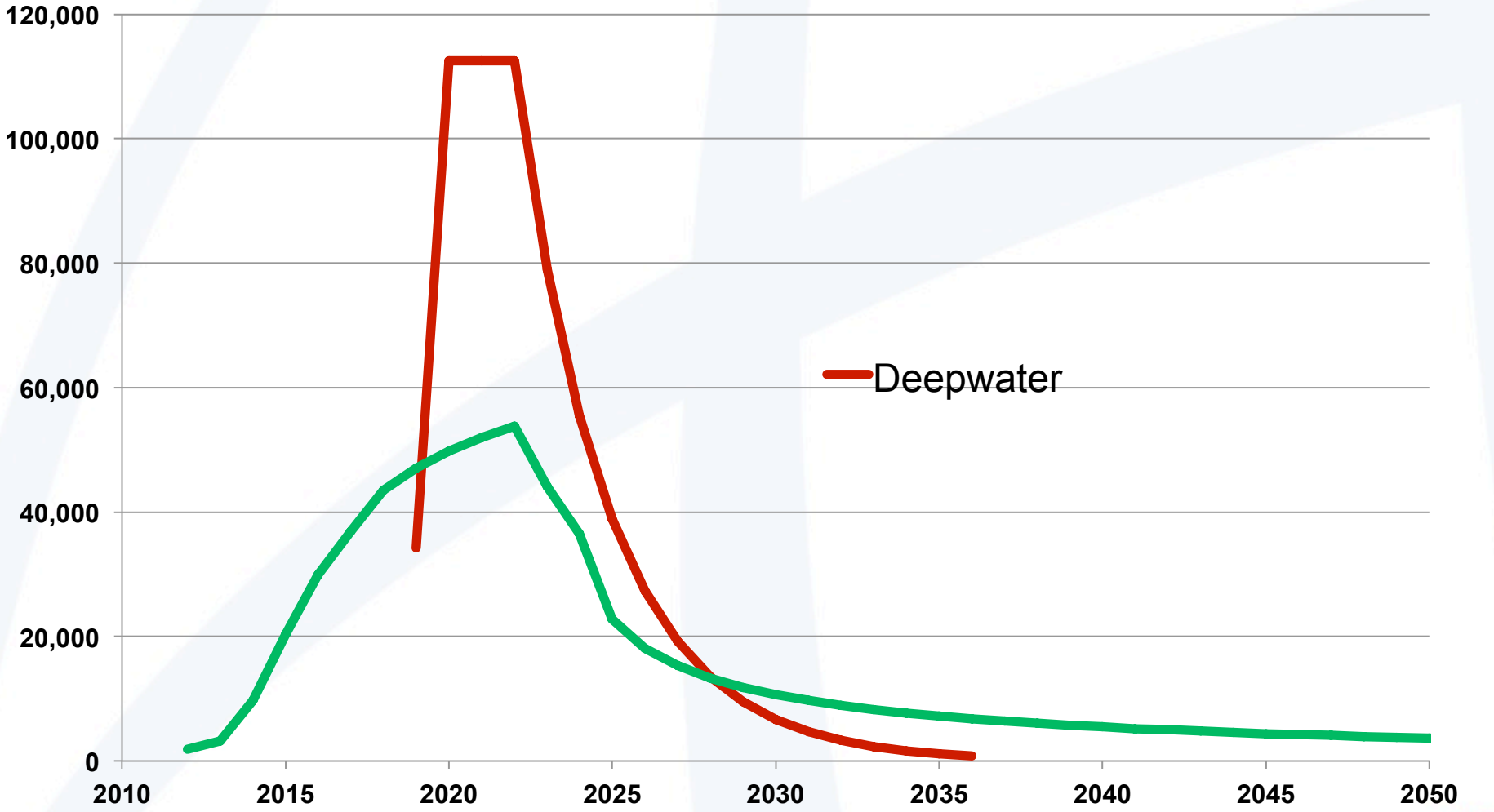
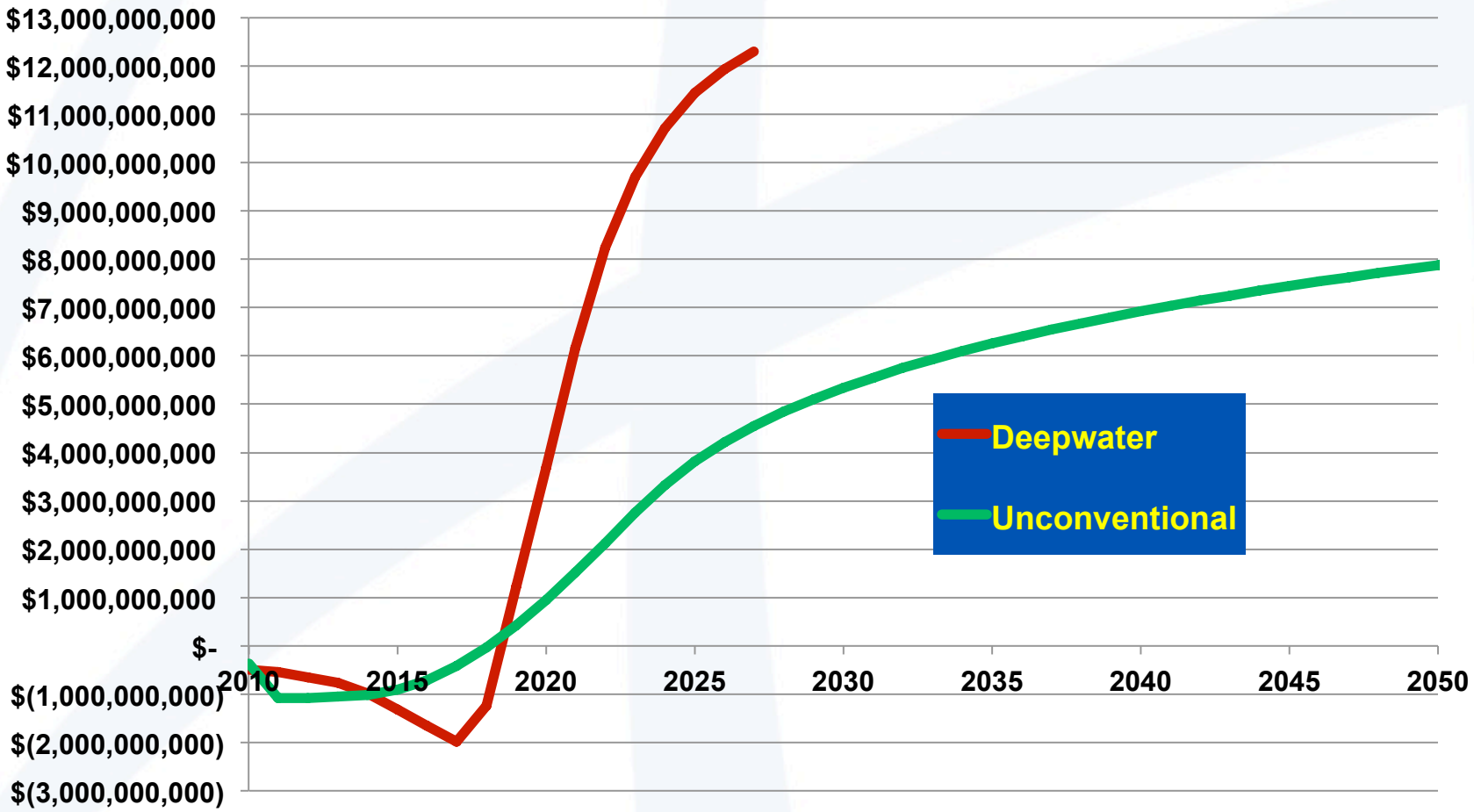
Example Comparison, Deepwater and Unconventional

	Deepwater	Unconventional
Oil recovery, MMBOE	100	100
Number of wells	7	333
Peak oil rate, BOEPD	45,500	34,500
Production life, years	13	55+
Time to first production, years	10	0.9
Maximum Negative Cash, $MM	1,769	410
IRR	14%	18%
Payout, years	10.7	7.6
NTIR (undiscounted) $/$	2.9	2.4
Total Inv, $/BOE	$ 20.99	$ 24.70

Production Profiles for a 250 MBO project---deepwater and a shale play



Comparison of cumulative cash flows 250



Example Comparison, Deepwater and Unconventional– 250

	Deepwater	Unconventional
Oil recovery, MMBOE	250	250
Number of wells	13	833
Peak oil rate, BOEPD	112,500	54,000
Production life, years	17	55+
Time to first production, years	9	0.9
Maximum Negative Cash, $MM	1,981	1086
IRR	24%	19%
Payout, years	9.5	9
NTIR (undiscounted) $/$	$6.4	$2.4
Total Inv, $/BOE	$9.42	$24.96

Some important distinctions

- Total unconventional land costs often exceed deep water bonuses per acre or per BOE.
- Reservoir characterization effort radically higher (early) for deep water projects.
- High cost deep water wells compared to “factory drilling.”
- Percentage of total well AFE going to rig owners vs. OFS (Shale “service intensity”)
- Much different risk profiles
- Upside: Deepwater has the upper hand
- Radically different completions

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Outline

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What is a shale, anyway?

- Most abundant type of rock in all sedimentary basins
- Most common source rock
- Most common trap (due to low permeabilities)

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What is a shale, anyway?

- Geologic definition is based on grain size
- Shales are sedimentary rocks composed of clastics (portions of older rocks) comprising silts, muds and clays.
- Silts are mainly quartzitic materials
- Clay minerals include kaolinite, montmorillonite-smectite, illite and chlorite.
- Muds are simply mixtures of water and very fine silt, clay and soil particles.

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What is a shale, anyway?

- Very fine grained organic material usually from plant materials are often deposited concurrently with the silt, mud and clay matter that will eventually form shales.
- Time, temperature and pressure result in hydrocarbon generation.
- A great deal of hydrocarbons are never expunged from low permeability shales.

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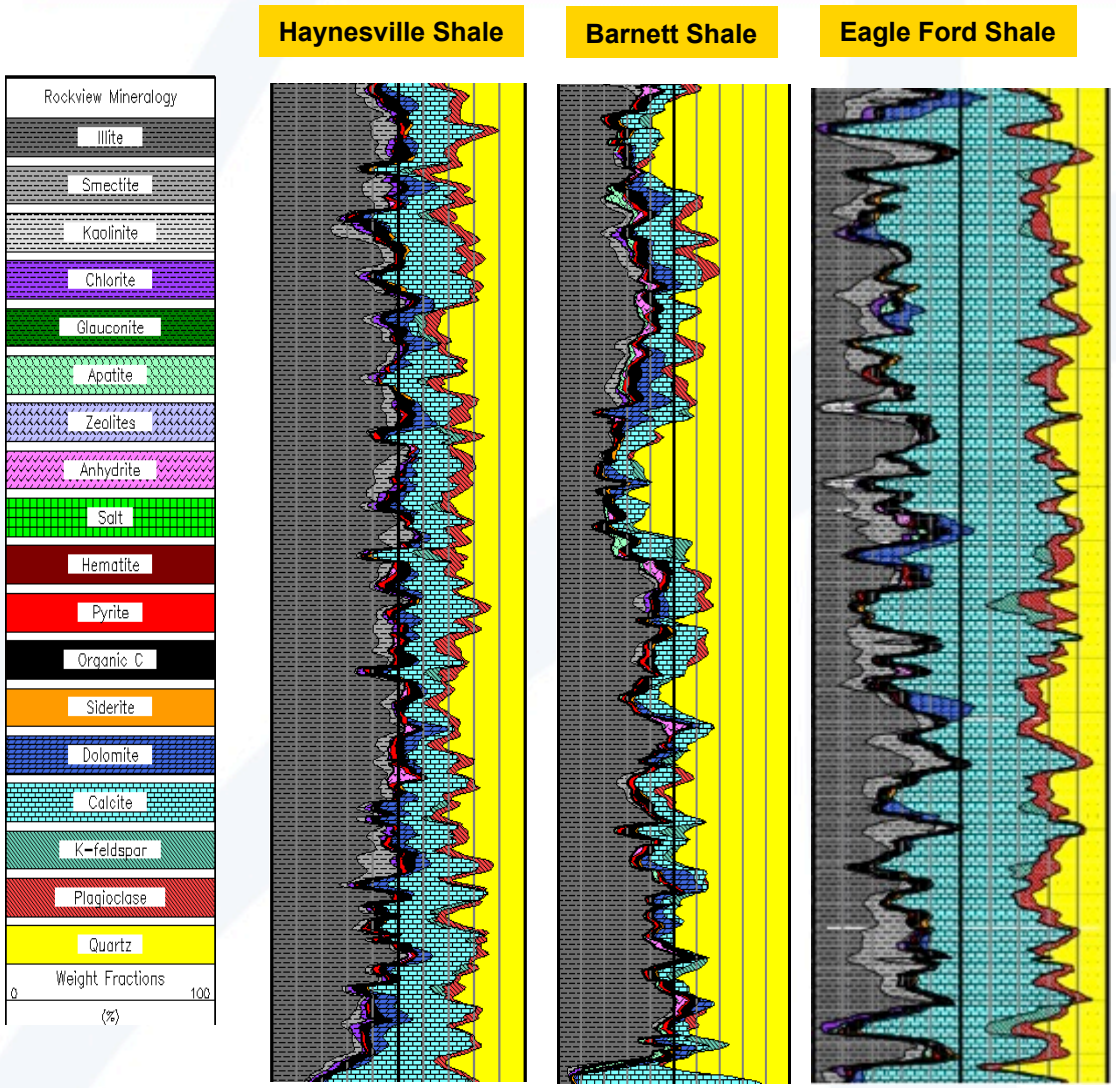
Shale Reservoir Lithology and Mineralogy



- **How is lithology/mineralogy information obtained ?**
  - **Mineral Spectroscopy Tools**
  - **Conventional Log responses**
  - **Mud Logs**
  - **Conventional or rotary SWCs**
    - **Various Core Analyses**

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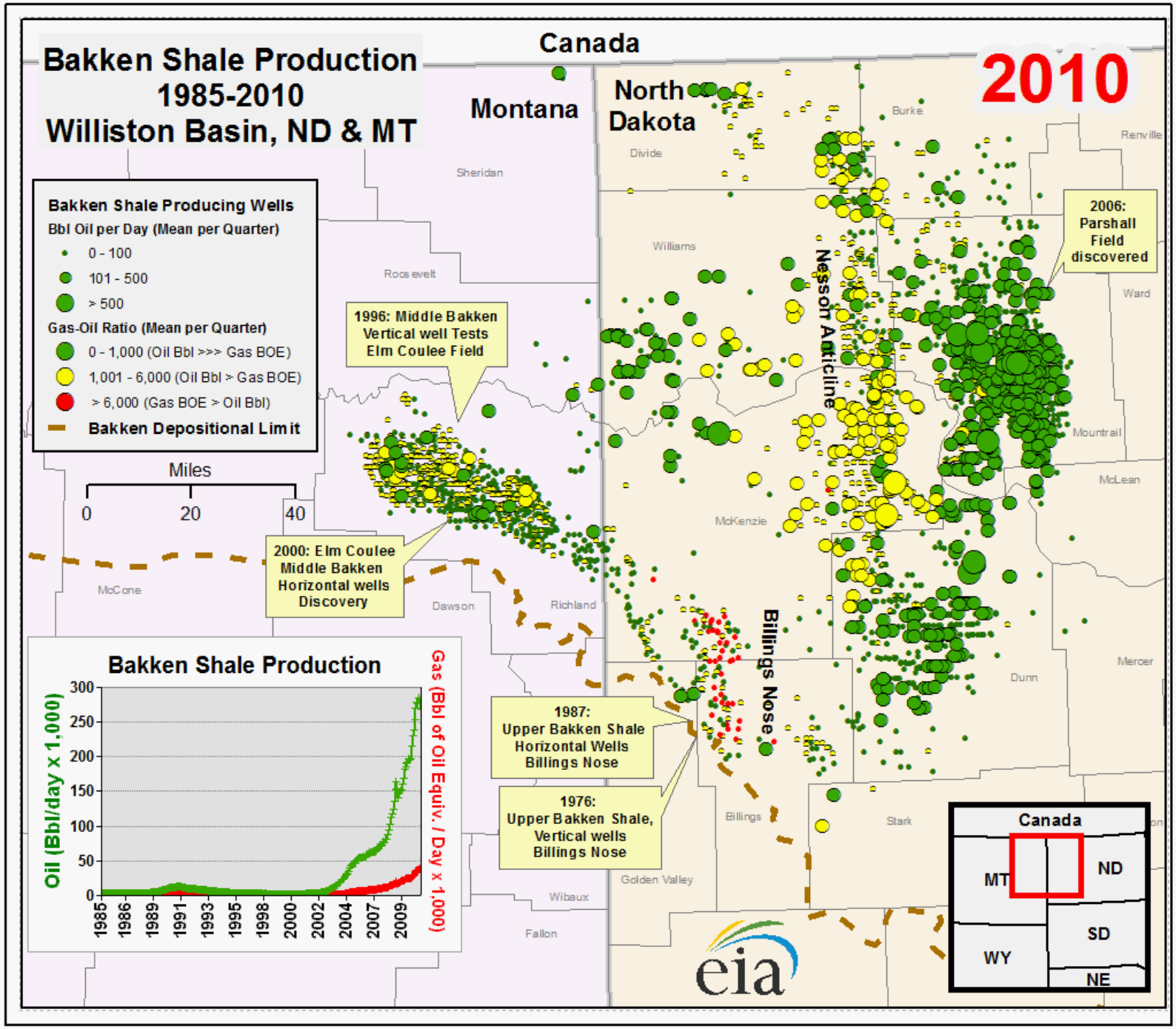
Bakken Shale Production
1985-2010
Williston Basin, ND & MT
Canada
Montana
North Dakota
2010
Bakken Shale Producing Wells
Bbl Oil per Day (Mean per Quarter)
0 - 100
101 - 500
> 500
Gas-Oil Ratio (Mean per Quarter)
0 - 1,000 (Oil Bbl >>> Gas BOE)
1,001 - 6,000 (Oil Bbl > Gas BOE)
> 6,000 (Gas BOE > Oil Bbl)
Bakken Depositional Limit
Miles
0
20
40
1996: Middle Bakken Vertical well Tests Elm Coulee Field
2000: Elm Coulee Middle Bakken Horizontal wells Discovery
2006: Parshall Field discovered
1987: Upper Bakken Shale Horizontal Wells Billings Nose
1976: Upper Bakken Shale, Vertical wells Billings Nose
Nesson Anticline
Billings Nose
Bakken Shale Production
Oil (Bbl/day x 1,000)
Gas (Bbl of Oil Equiv. / Day x 1,000)
300
250
200
150
100
50
0
1985
1986
1989
1991
1993
1995
1998
2000
2002
2004
2007
2009
Sheridan
Roosevelt
McCone
Dawson
Richland
Wibaux
Fallon
Divide
Burke
Renville
Williams
Ward
McKenzie
Mountrail
McLean
Billings
Golden Valley
Stark
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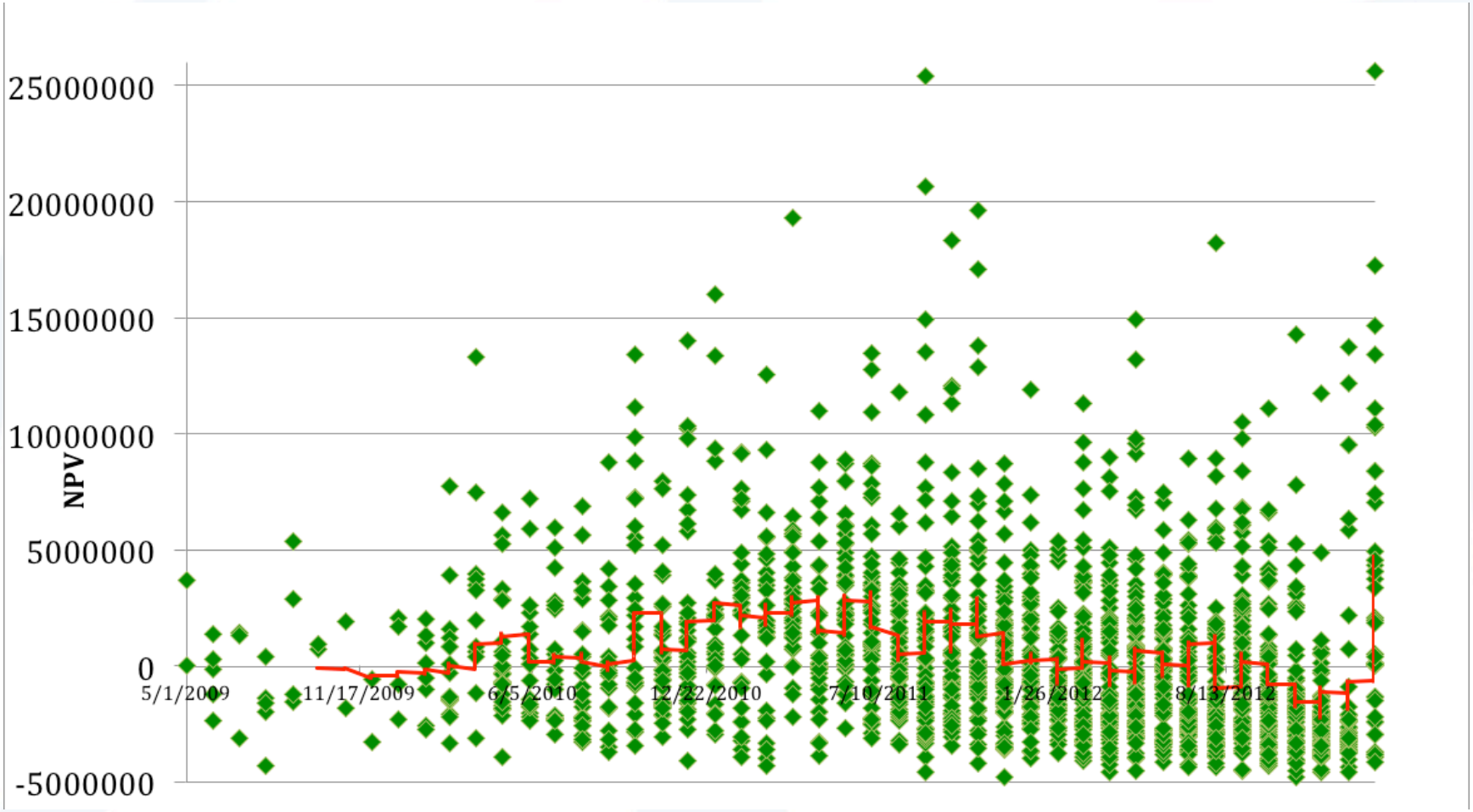
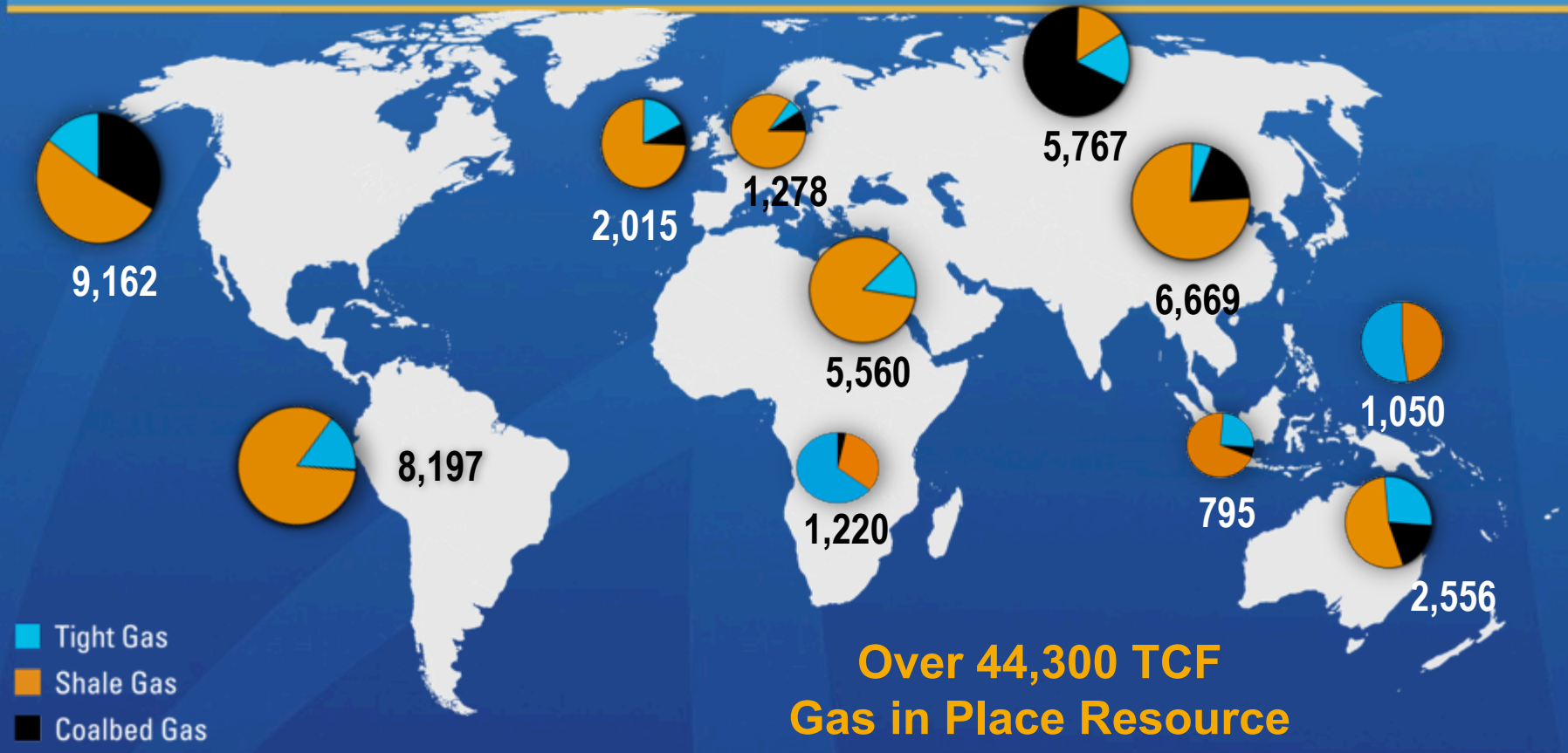
NPV10 ATAX



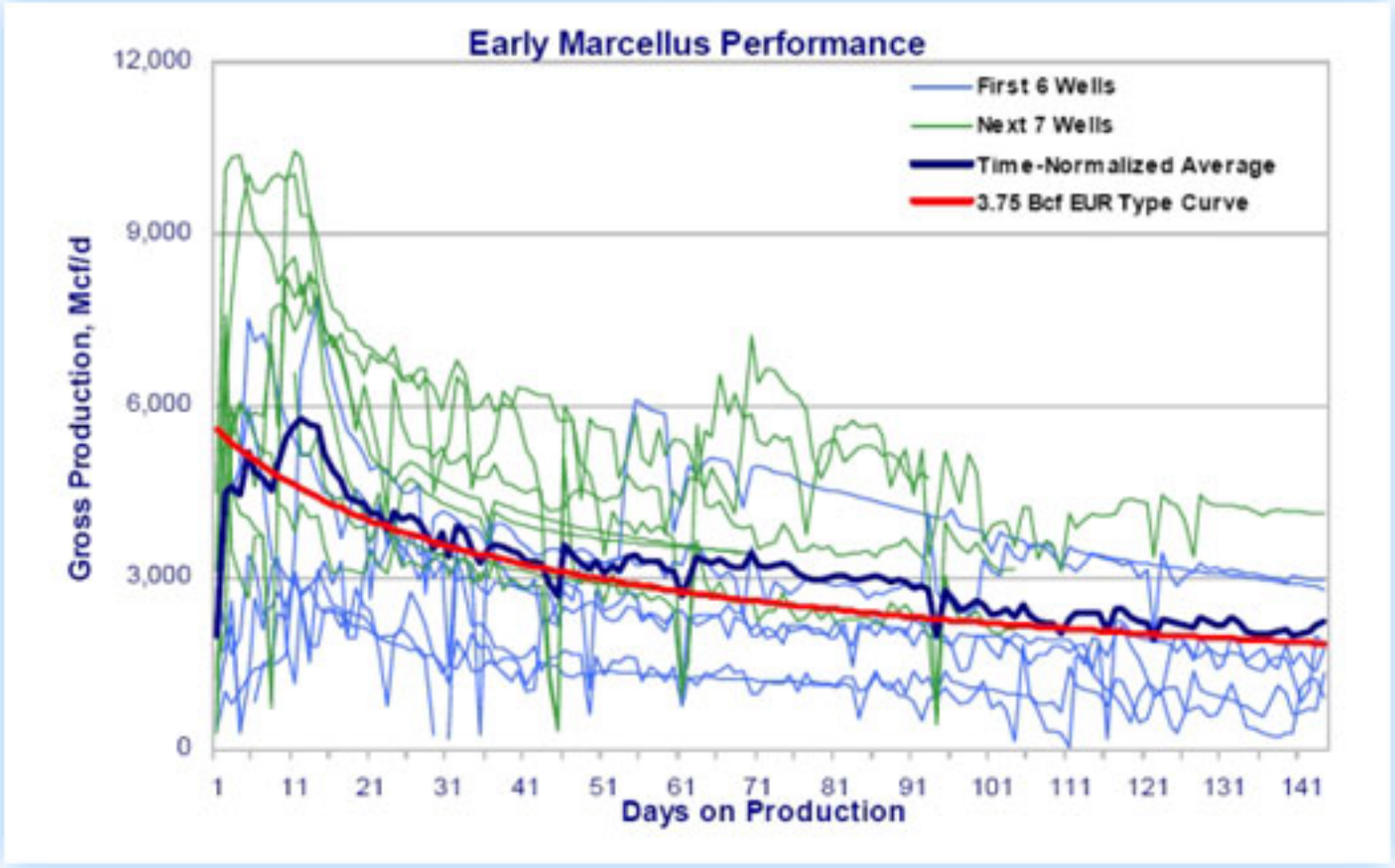
Global Gas In Place Resources



Over 44,300 TCF
Gas in Place Resource

Source: Baker Hughes, EIA, SPE 68755, Kawata & Fujita from Rogner

Highly variable production by well

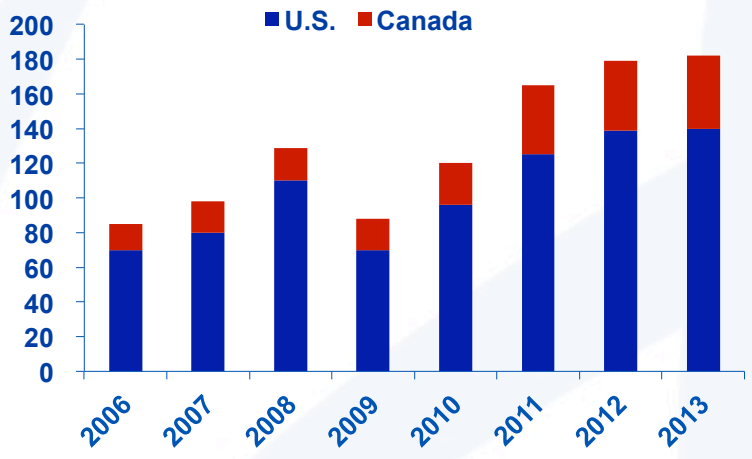


A Major Transition Occurred in 2012

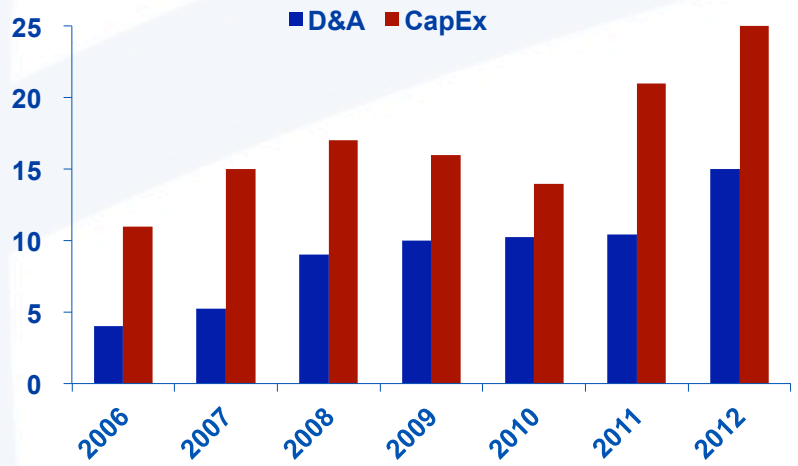
	Key Success Factors	
	"Capture Phase" (2002 - 2012)	**"Harvest Phase" (2012 - ?)**
Oil & Gas Companies	• Land grab ("gold rush") • Spend, spend, spend • Cheap financing Everyone Wins	▪ **Better be "oily"** ▪ **Drive efficiencies or perish** ▪ **Generate both growth & FCF** **Only The Best Win**
Service & Equipment Companies	▪ **Add capacity** ▪ **Raise prices** ▪ **Have fun**  **Everyone Wins**	▪ **Right basins** ▪ **Right services to drive efficiencies** ▪ **Low cost, high quality** **Only The Best Win**

Sector spending large and growing…. but

Historical & Forecast North American E&P Spending ($Billions)



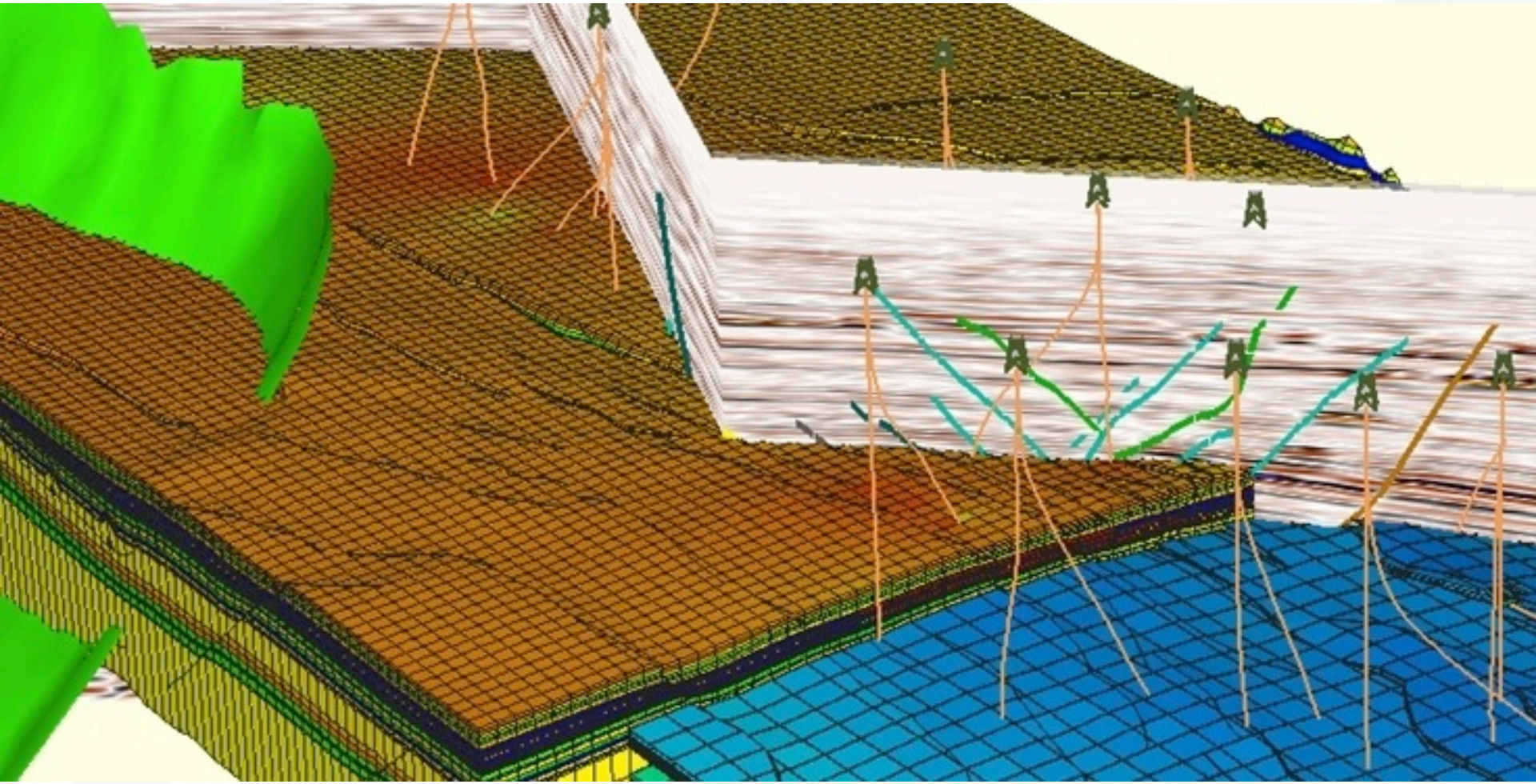
OSX Capital Expenditures and D&A ($Billions)



SPE ATW Risks

- Availability of leases (land access) and “operability”
- Water availability
- Well costs
- Low gas prices
- Gas infrastructure
- Access to “risk capital”
- Service company capabilities
- Government regulations
- Lack of numerous risk seeking firms (fast failure and technology acceleration)
- Geomechanics– inability to frac effectively
- Lack of productivity/commercial quality resource

Questions?

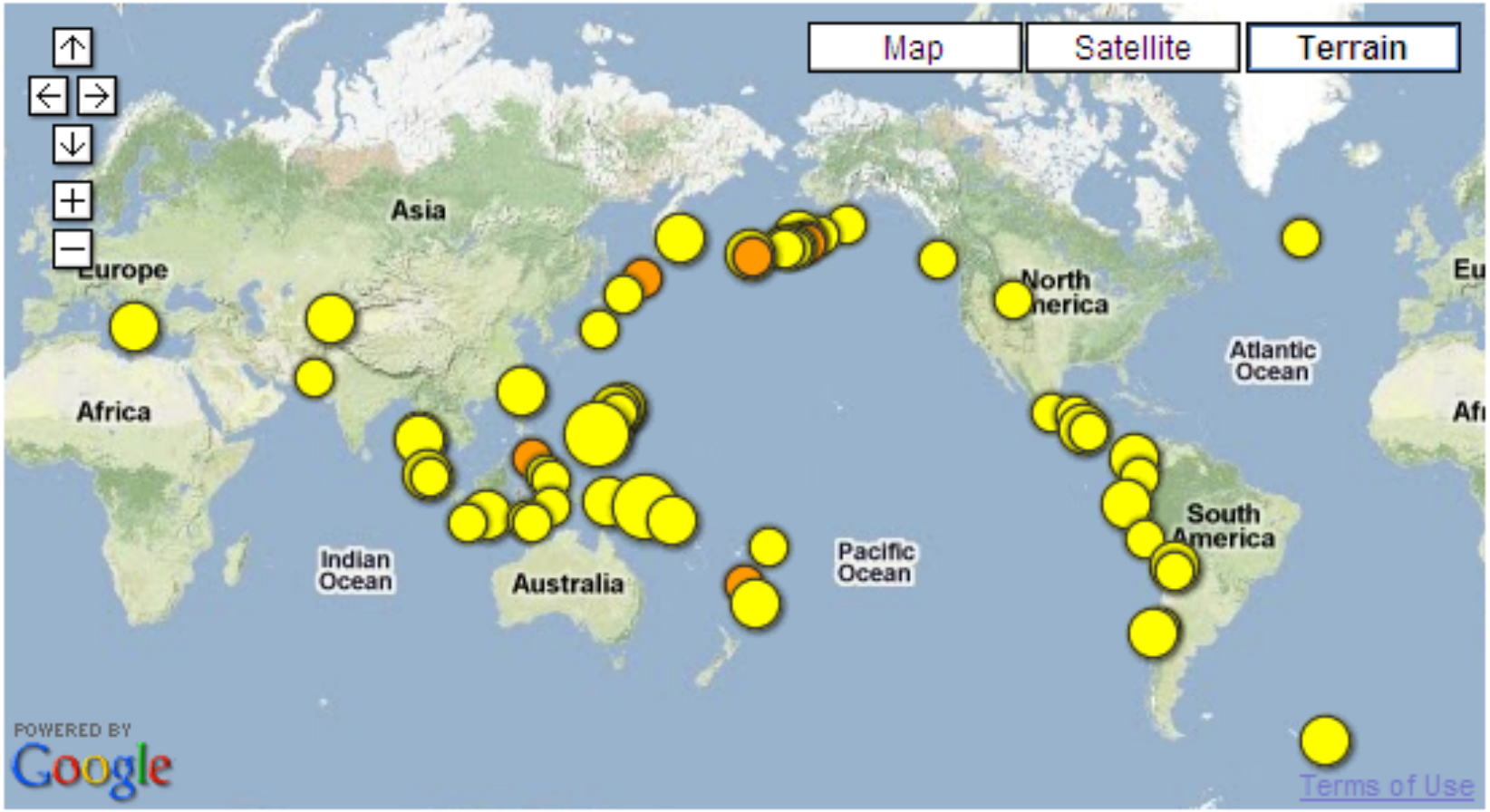


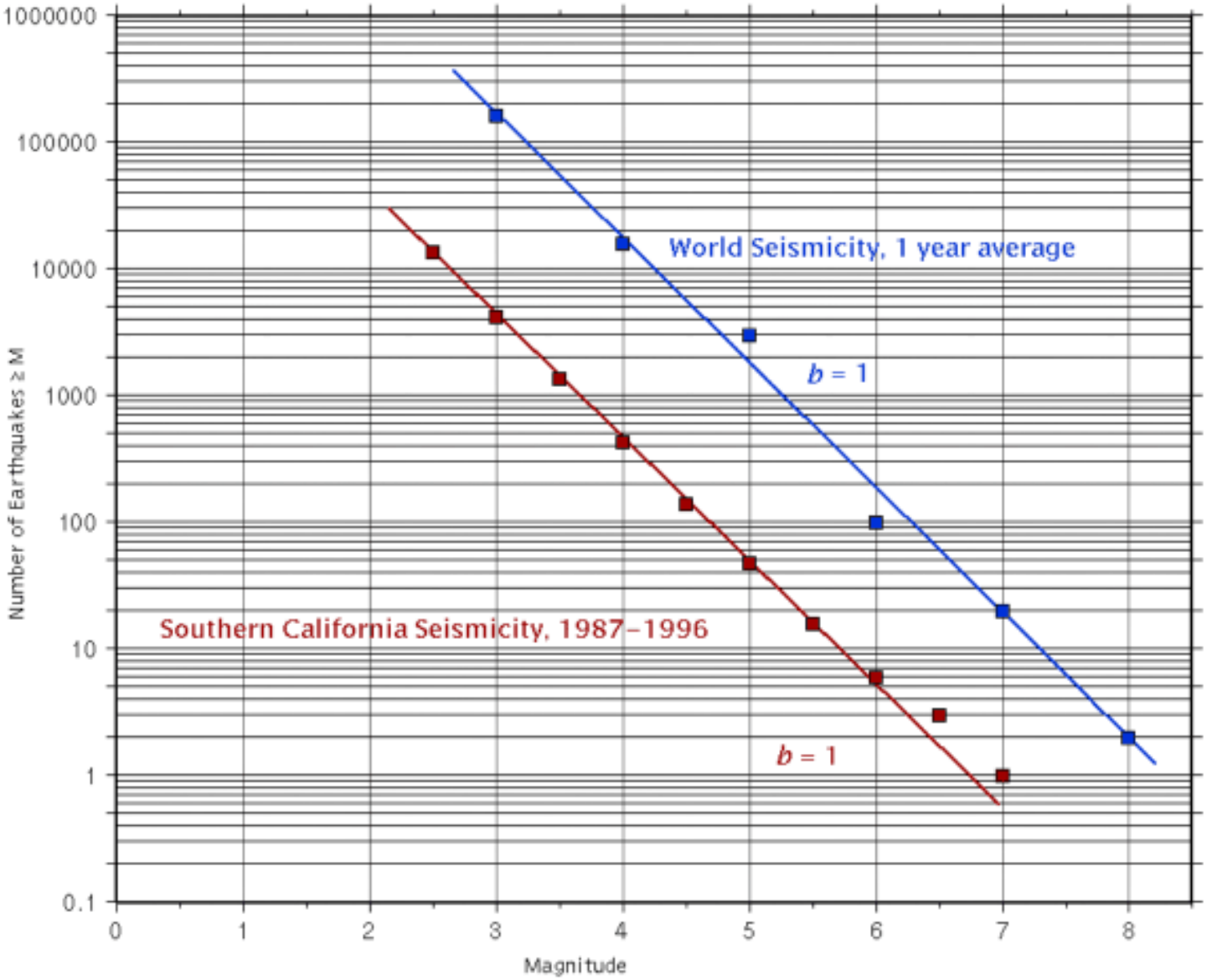
USGS Real-time Earthquakes

M 4+ Earthquakes, Past 7 Days

70 earthquakes on this map

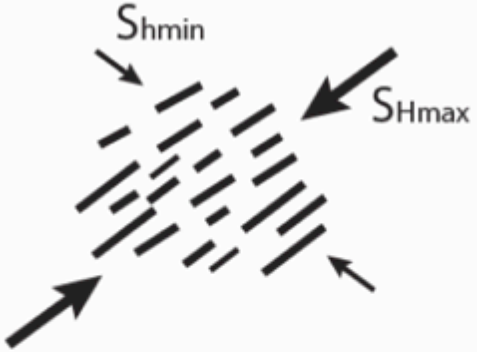
Updated Mon, 23 Aug 2010 20:32:42 GMT

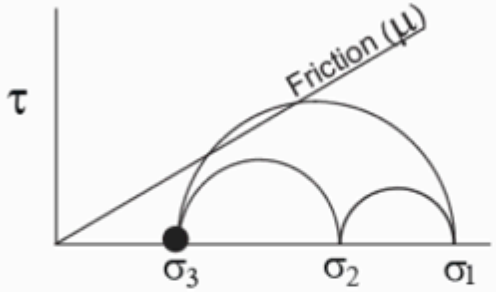




Gutenberg-Richter Plot

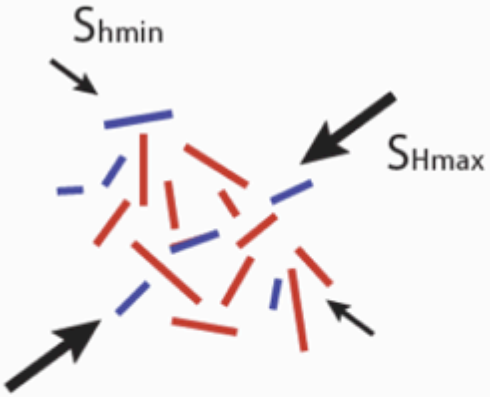
Stressed" Fractures

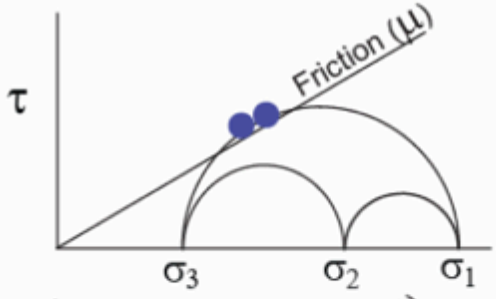




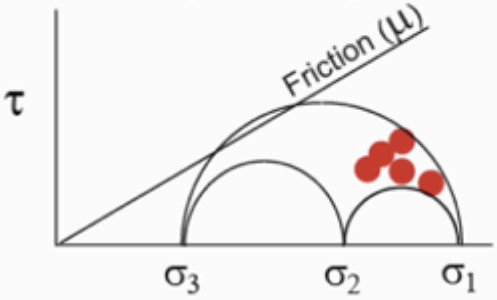
Conventional Thinking:
Mode I "Opening mode"

Map view





Hydraulically Conductive:
Repeated fault slip
maintains permeability



Hydraulically Non-Conductive:

Stable fractures

Fractures proximity to frictional failure is highly dependent on the relative stress magnitudes and pore pressures in the reservoir

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