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Reservoir Drivers in the Selection of Wet versus Dry Tree Facility Solutions

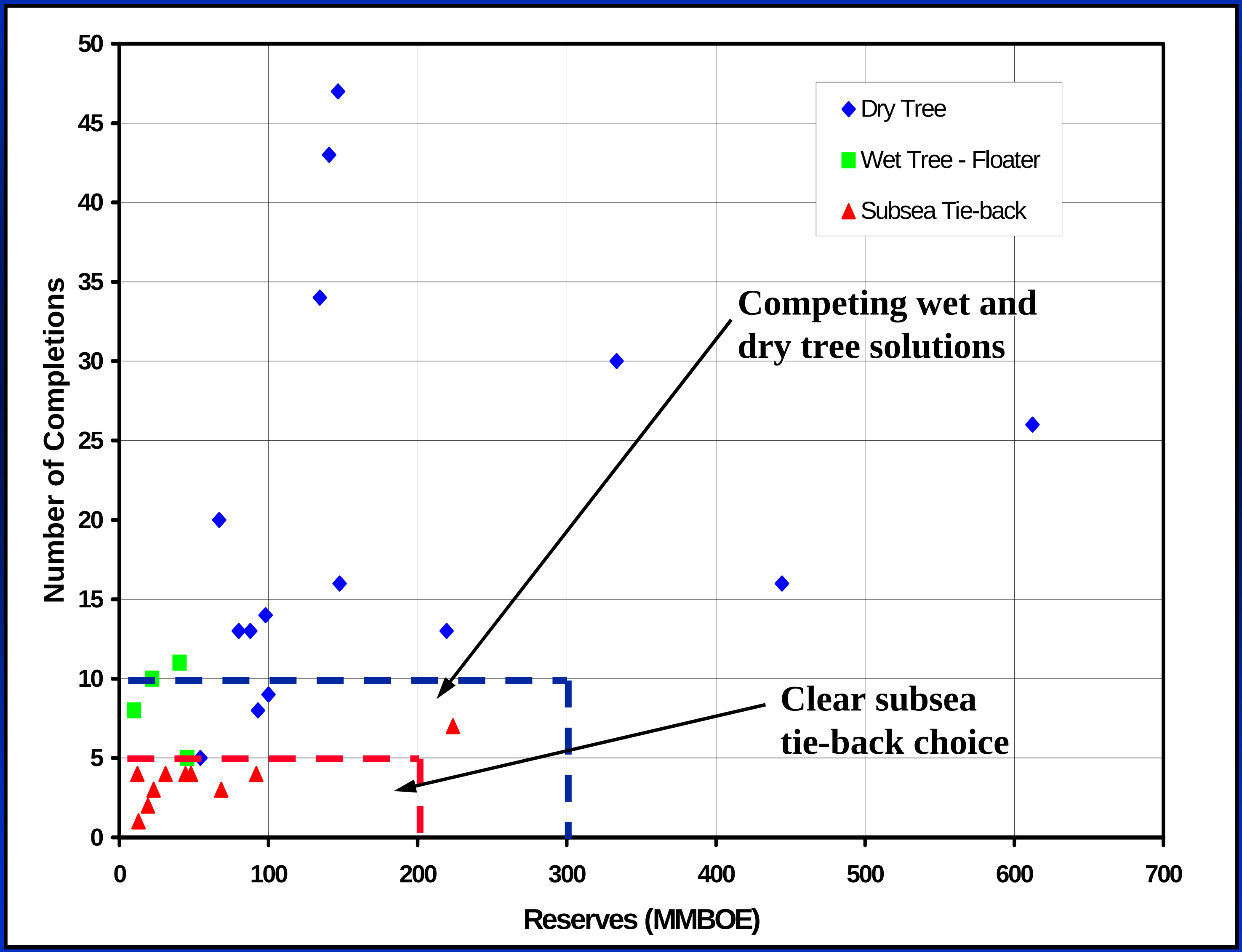
knowledgereservoir

Outline of presentation

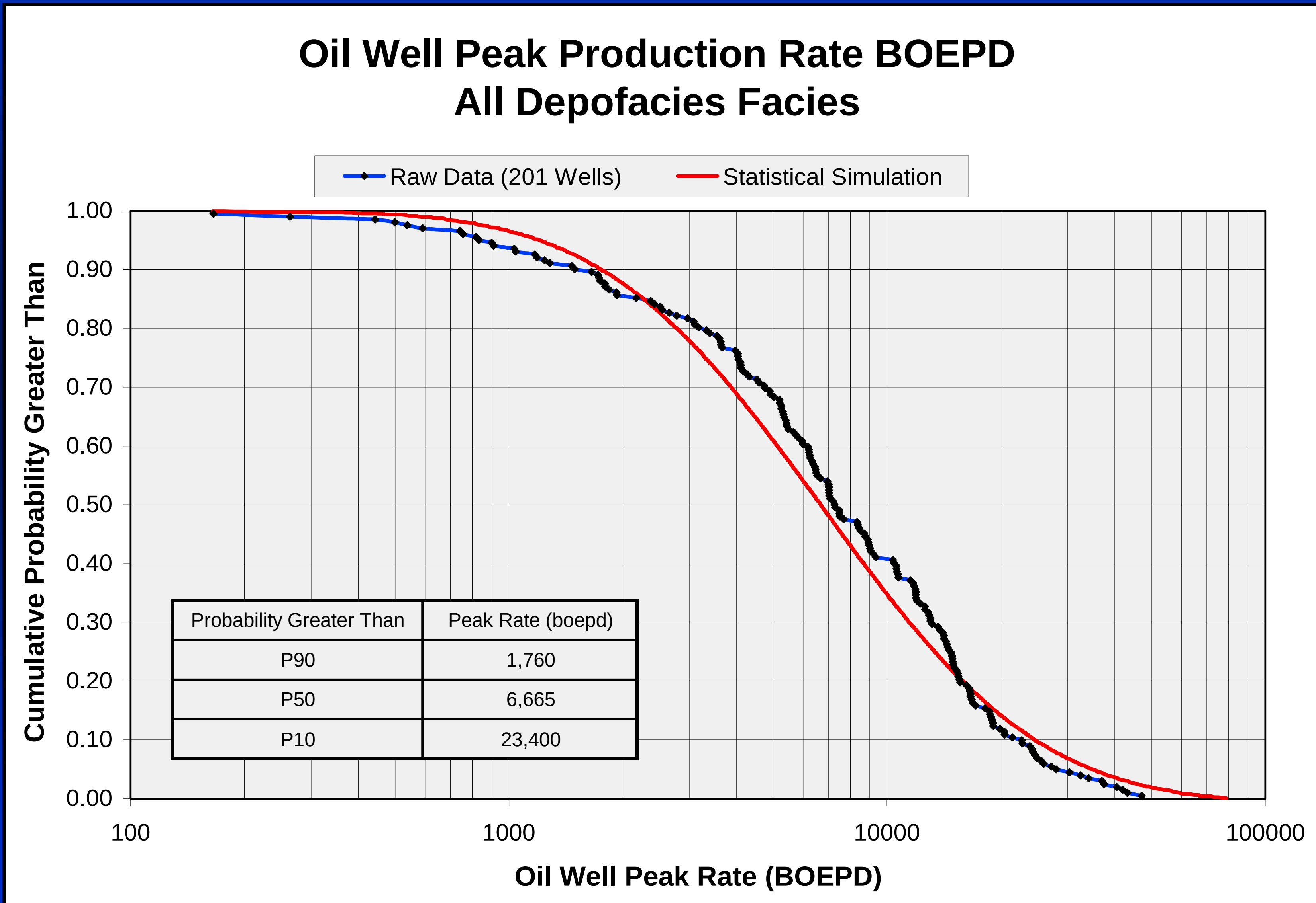
- **Focus on oil reservoirs in deepwater Gulf of Mexico**
- **Pleistocene – Pliocene – late Miocene reservoirs**
  - **Introduction to ReservoirKB**
  - **Peak flow rate, reserves per well, and the influence of depositional facies**
  - **Drive mechanism**
  - **Effects of water injection and water production**
- **New provenances: Early Miocene to Paleogene age and subsalt**
- **Summary**

Gulf of Mexico deepwater fields

Number of wells by facility type

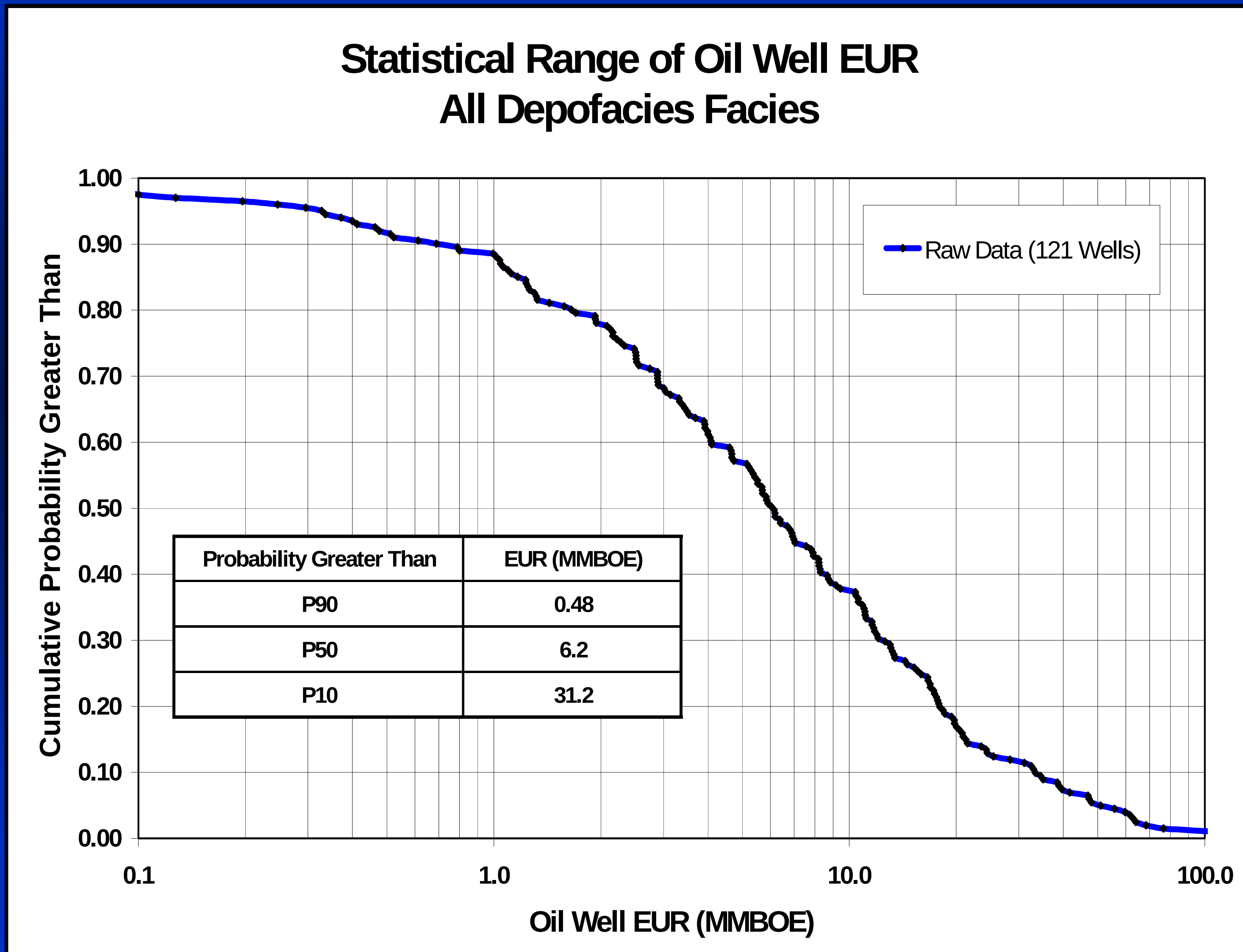


Highly productive wells



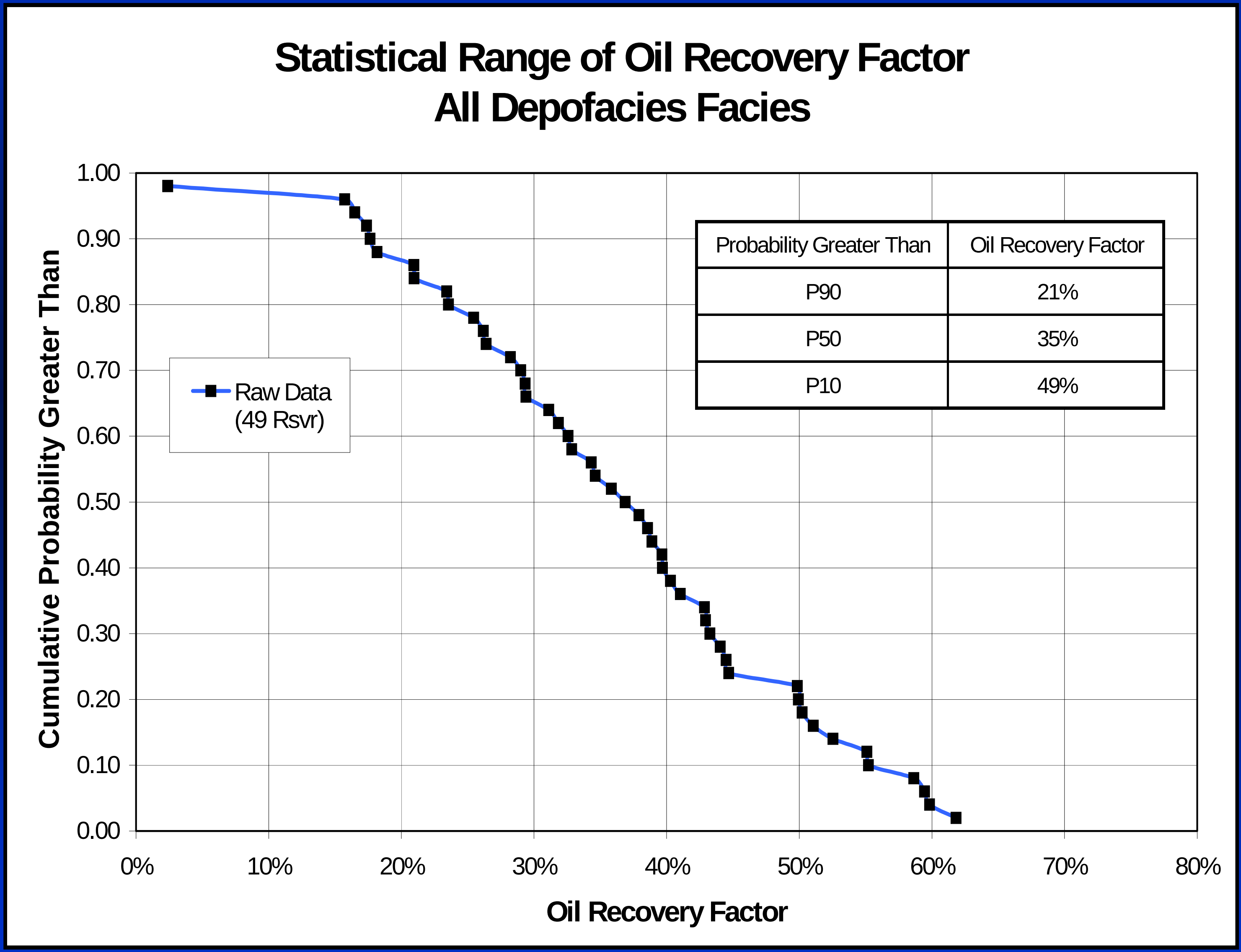
Probability Greater Than	Peak Rate (boepd)
P90	1,760
P50	6,665
P10	23,400

Oil recovery per well per reservoir

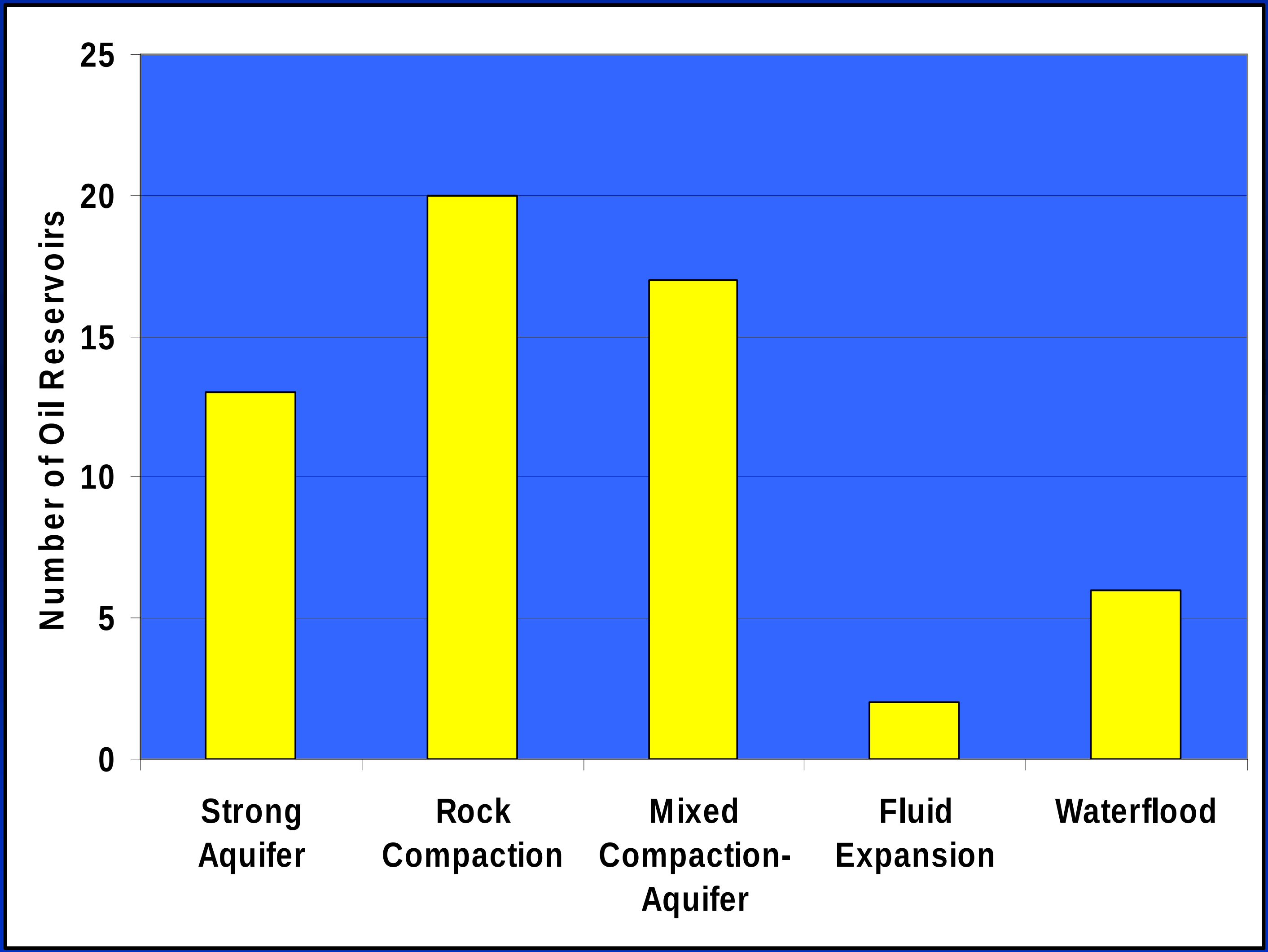


Probability Greater Than	EUR (MMBOE)
P90	0.48
P50	6.2
P10	31.2

Oil recovery factor



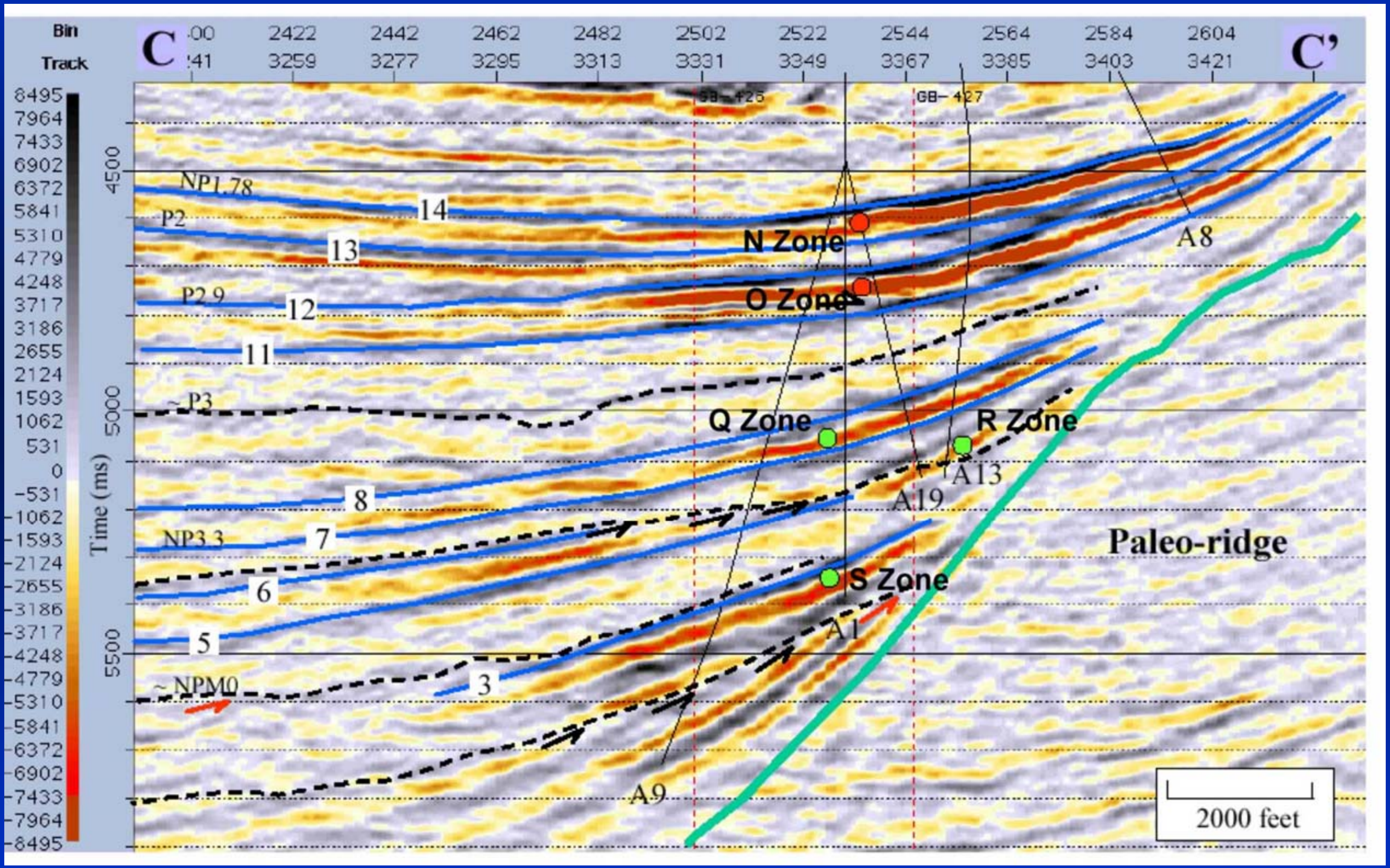
Reservoir drive mechanism



Summary of deepwater GoM reservoir characteristics

- Late Miocene, Pliocene and Pleistocene age sandstone
- Stacked reservoirs
- High flow rate wells
- Over-pressured reservoirs
  - Drive mechanism often rock compaction and aquifer influx
  - High primary recovery factors
  - Only few waterfloods (i.e. Lobster and Petronius)
- Fast depletion rates due to reservoir size and well flow rates
- Re-use of deep and expensive appraisal wells

Stacked Reservoirs – Auger example



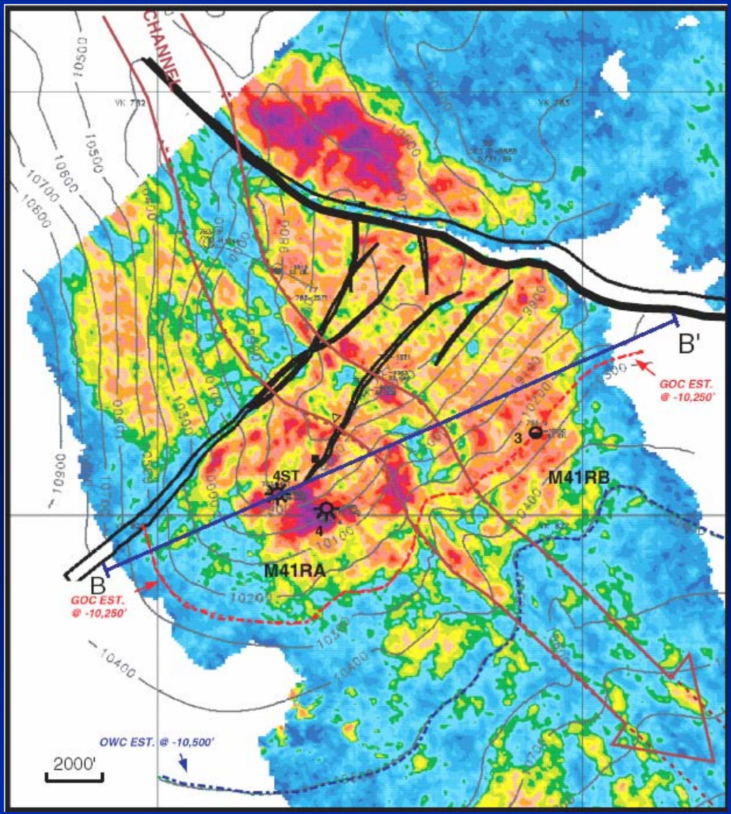
Auger Field example from Booth, 2002

Reservoir complexity impacts rig activity

- Deepwater turbidite classification:
  - Sheet sands
  - Levee sands
  - Channel sands

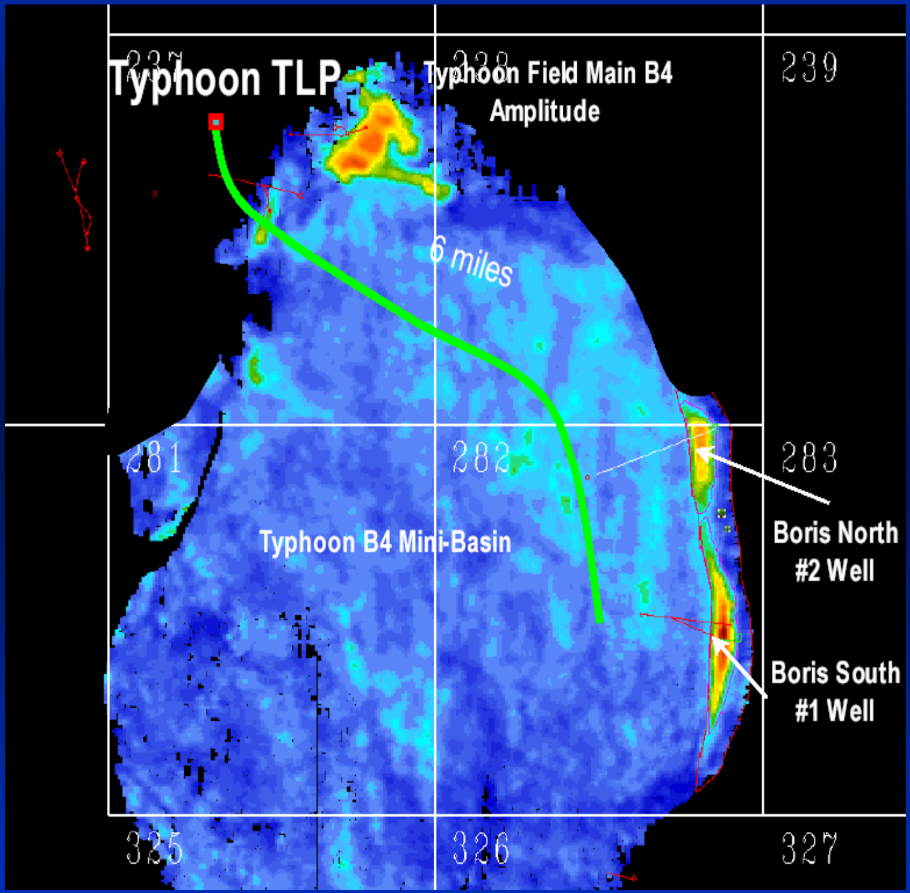
↓ *Increasing complexity and often poorer well performance*

- Channel sands have greater risk of limited drainage volumes
- Reservoir compartmentalization from faulting associated with salt movement and amalgamation of turbidite channels



Kendrick, 2000 GCSSEPM, Tahoe Field

Well reliability and management



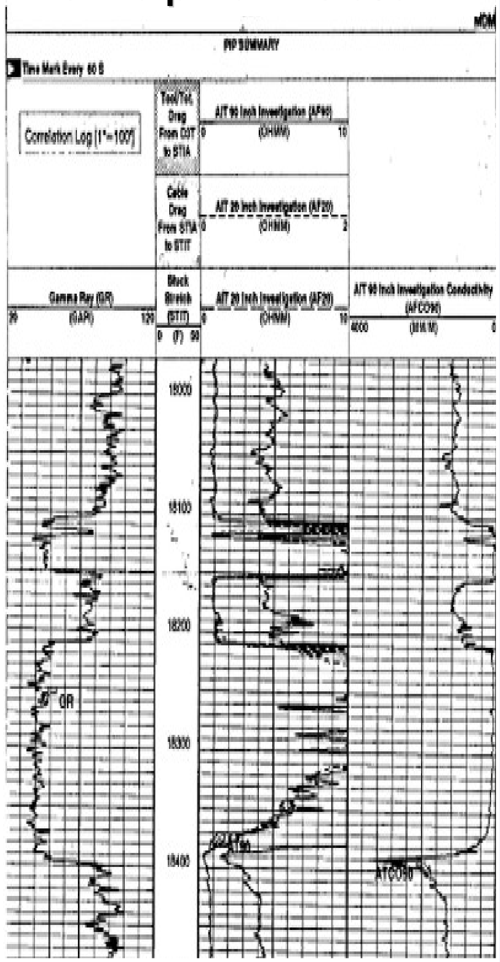
Coludrovich, SPE 90316 (2004)

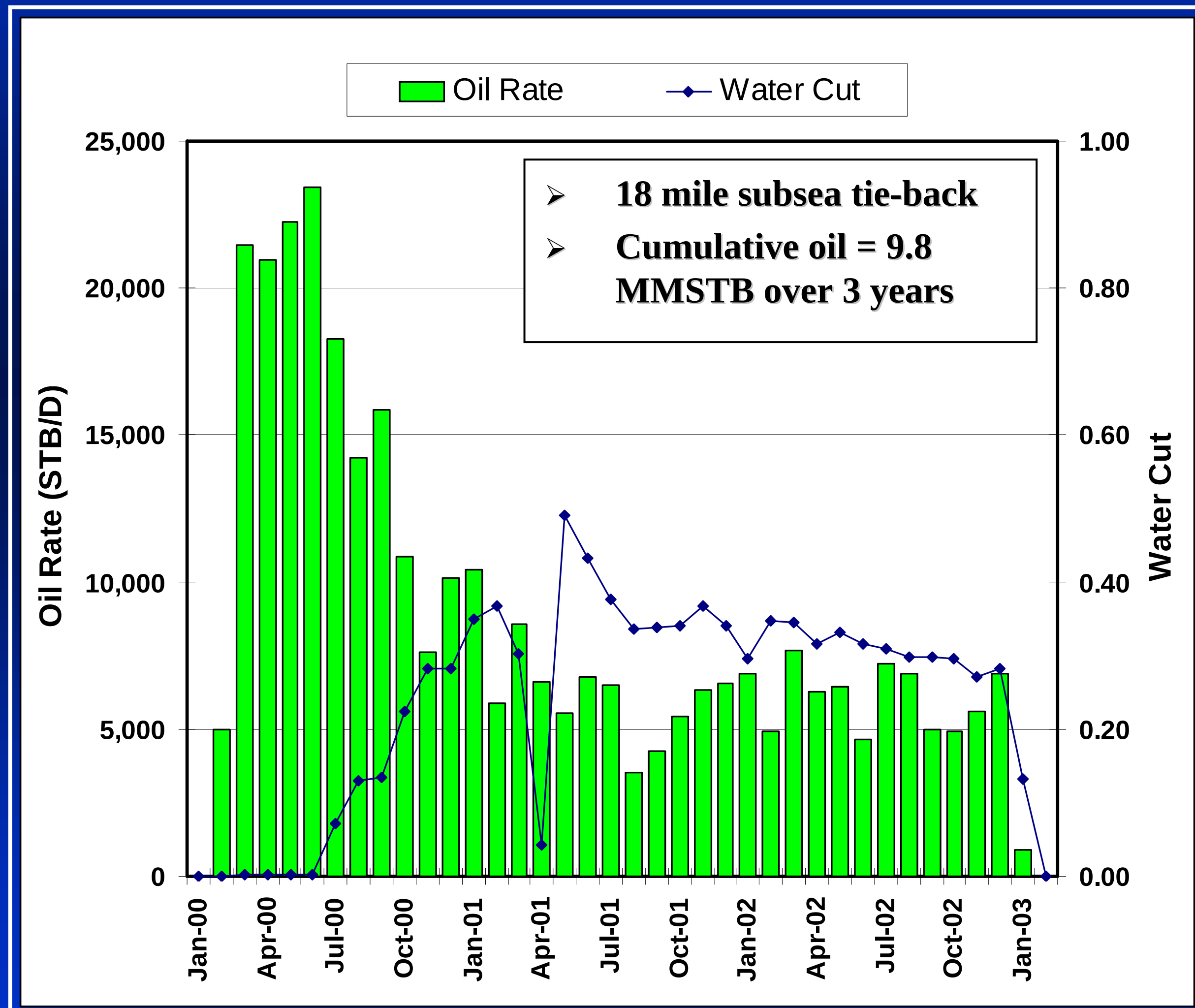
- Boris Field, 6 mile subsea tie-back
- Completion includes downhole Expro 2-phase venturi flow meter
  - 3 pressure gauges and temperature
  - Oil / water rates and fluid density
- Rates / pressures available by well
- Transient analysis for permeability and skin
- Sand control management using drawdown and flux
- Set operating parameters to minimize risk of completion failure

Water production in subsea well

Europa Field “L” sand, well A-1

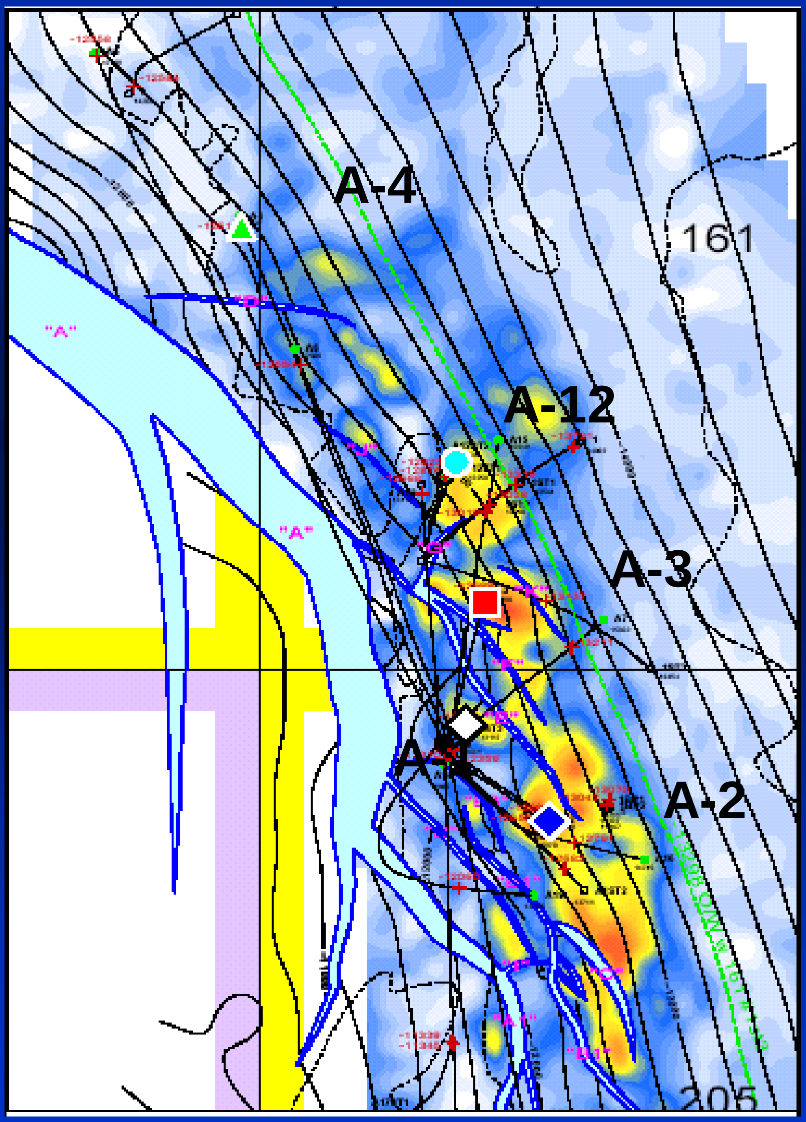
Downdip well MC 935 #2

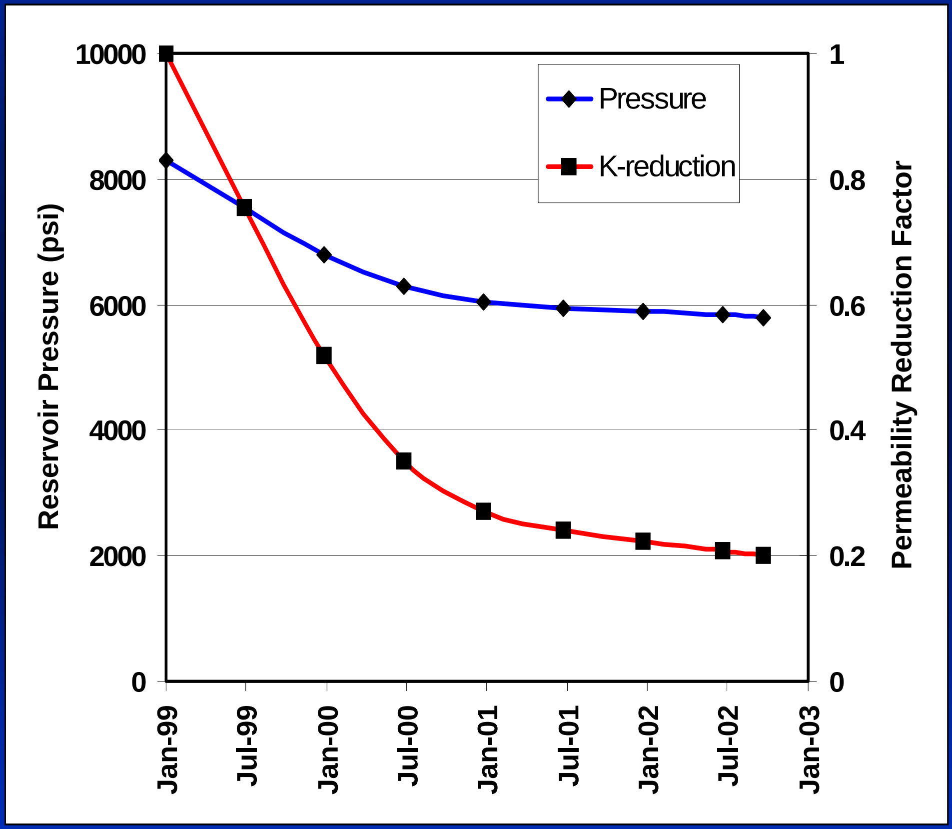




Genesis Field, N3L Sand

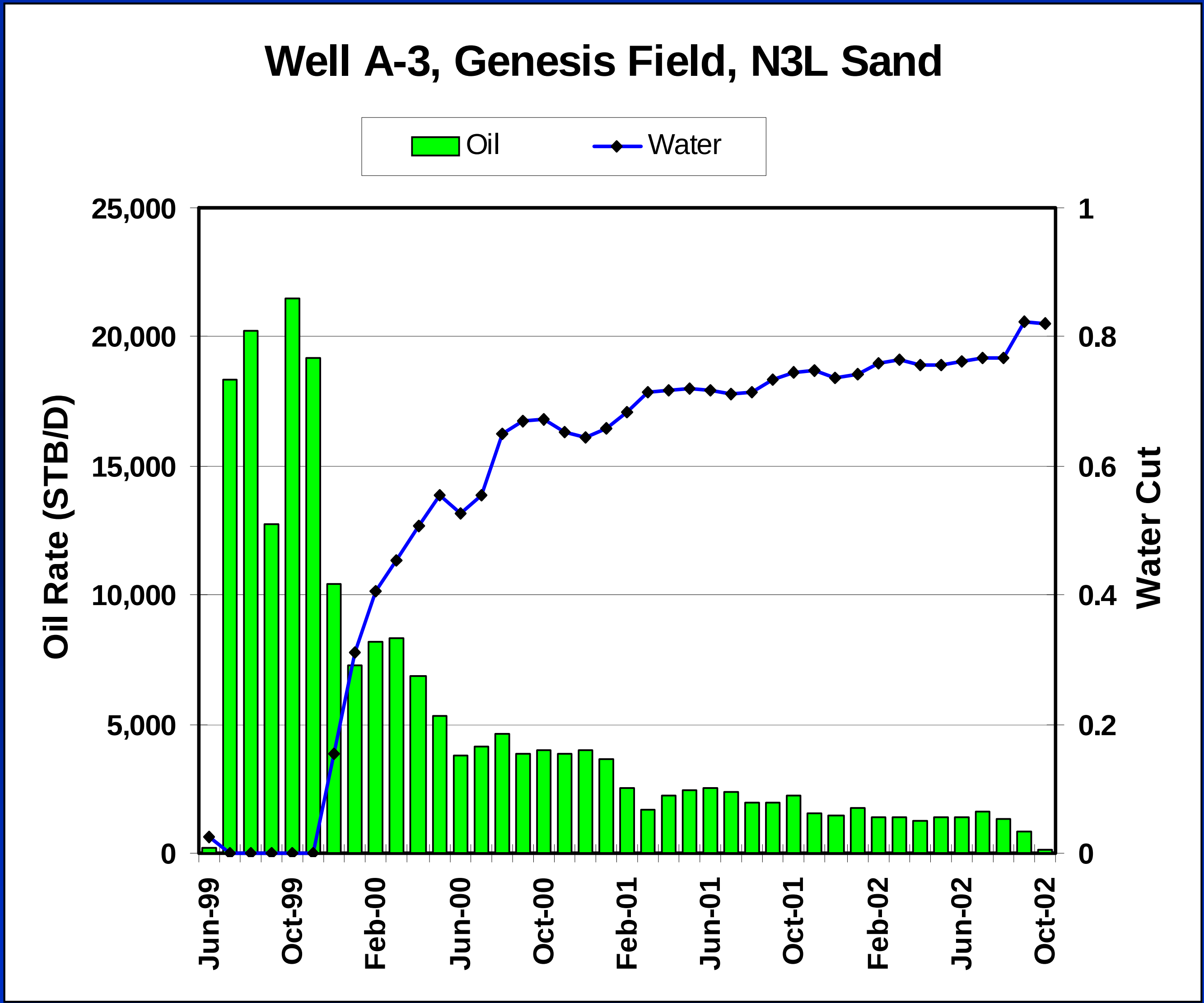
Compaction and Water Production





Pourcaiu, SPE 84415 (2003)

Genesis Field, N3L Sand (cont'd)

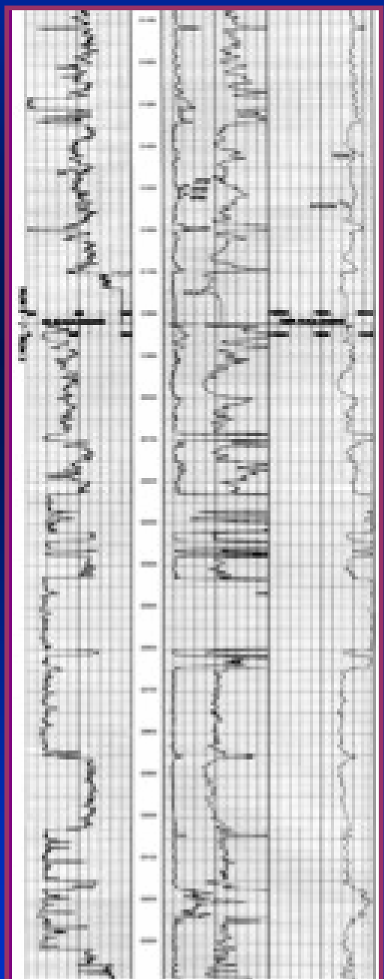


New GoM Provenances
Early Miocene to Paleogene

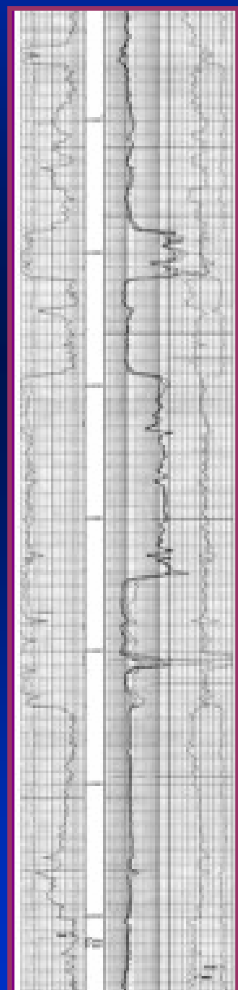
- Depths 20,000 to 30,000 feet
- High pressure (>15,000 psi) and temperature
- Basin floor fans (sheet sands)
- Seismic imaging issues due to salt and depth
- Low rock compressibility, consolidated rock
- Primary depletion recoveries ~ 10 to 20%
- Water injection or aquifer influx necessary for increased reservoir recovery
- Paleogene reservoirs with low porosity and permeability

Thunder Horse Field example

Thunder Horse
MC 778 #1

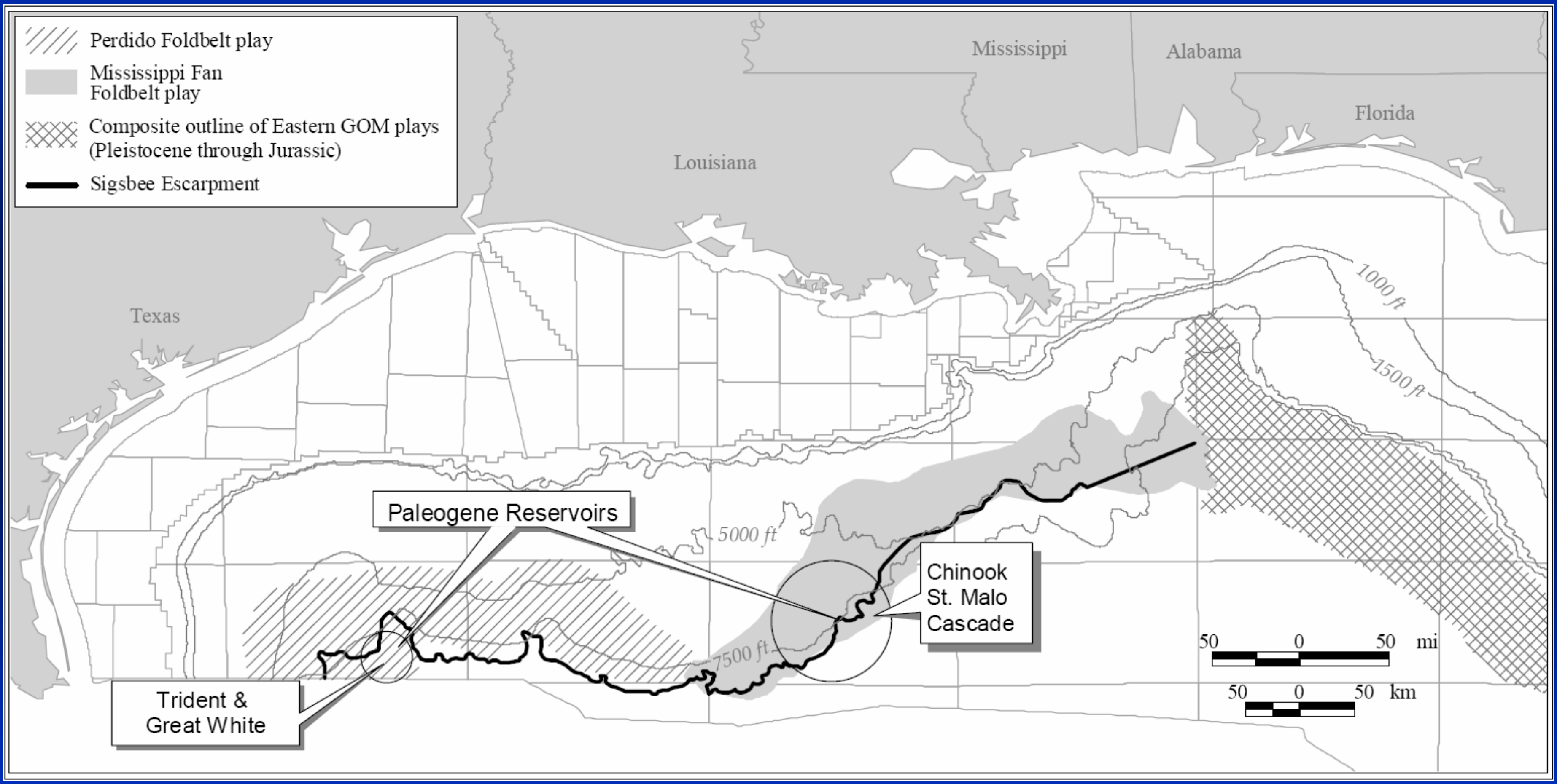


Thunder Horse North
MC 776 #1



- 2 primary reservoirs
- Middle/Early Miocene basin floor sheet sands
- Pi = 16,000 psi, Tr = 235 F, Depth ~ 22,000 ft
- Reserves size ~ 1,000 MMBOE
- Development plan
  - 20 Wet tree wells (includes water injection wells)
  - 250,000 bbl oil /day peak rate
  - 300,000 bbl/day water injection
  - Significant produced water handling
- Sand control ?
- Well rates > 20,000 bbl/day

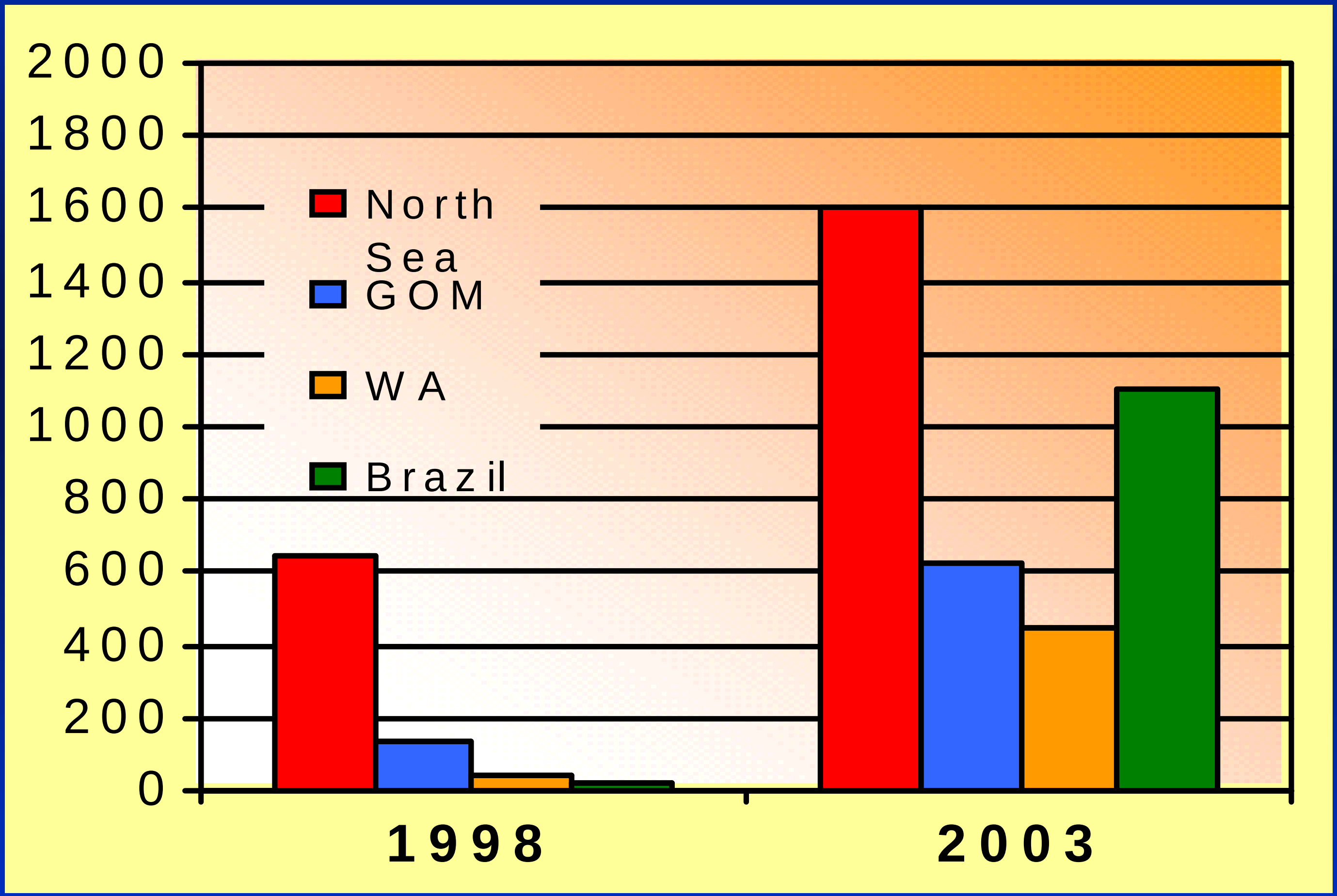
Paleogene Potential



Minerals Management Service, Deepwater Gulf of Mexico 2004: America's Expanding Frontier

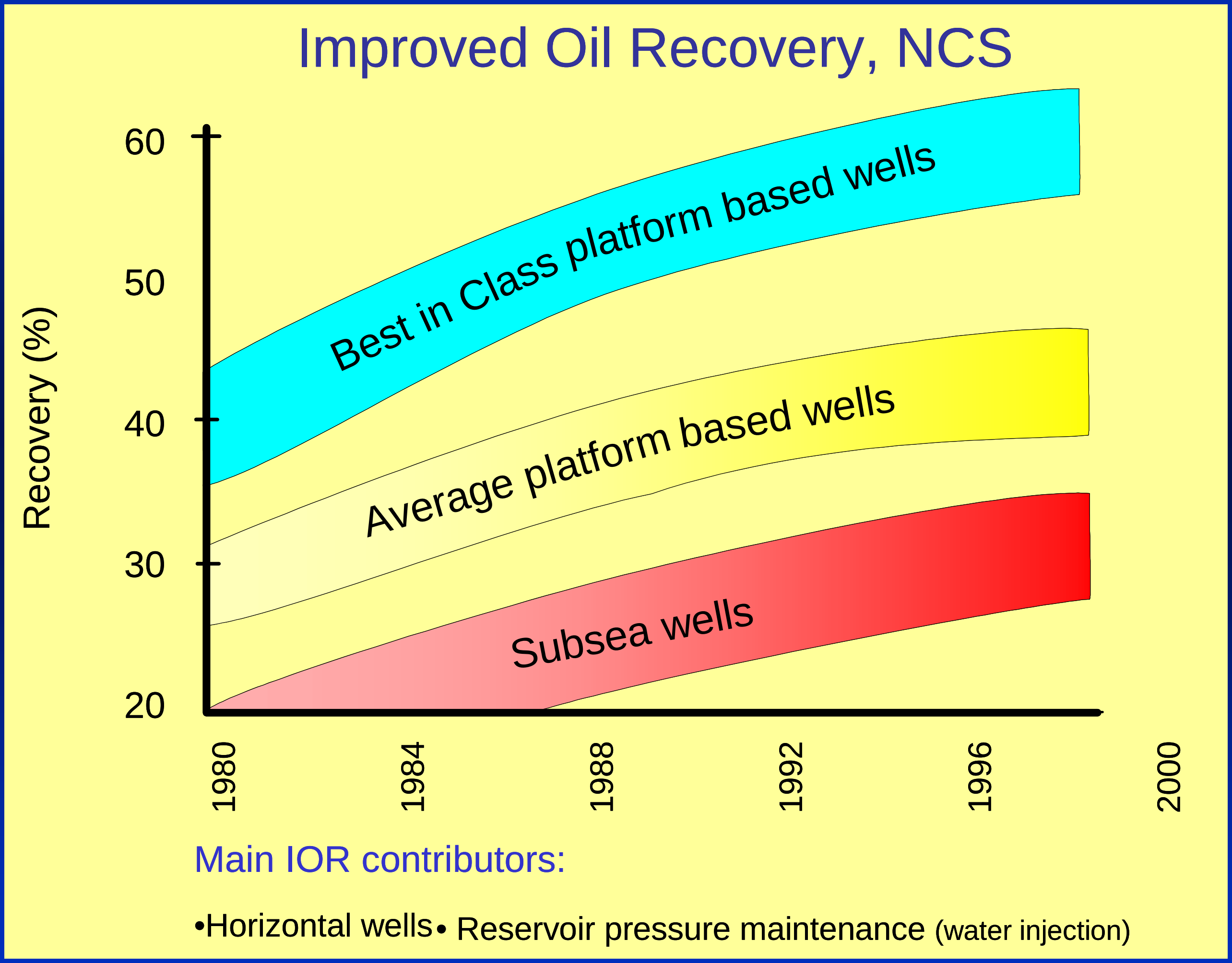
Worldwide use of Wet Trees

Global increase in Subsea Wells



ResLink Study, Norwegian Continental Shelf study

Oil recovery - wet vs dry tree wells



ResLink Study, Norwegian Continental Shelf study

Summary of reservoir drivers

- Number of wells and reservoirs → total rig activity
- Reservoir size and fluid type
- Field distance to local infrastructure
- Operator's global subsea experience (North Sea and West Africa)
- Reservoir complexity
- Maximizing re-use of appraisal wells
- Ensuring fast ramp-up and field uptime reliability