Stretching The Technology Envelope

(Gulf of Mexico)

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Chevron North America Exploration and Production Company

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Outline

- Technology Enhancement Objectives
- Offshore Challenges
  - Exploration Imaging
  - Drilling
  - Completion
  - Production Systems
  - Export Systems
- Addressing Technology Issues
- Regulatory Modifications

Deepwater Gulf of Mexico – America's Expanding Frontier (OCS Report - MMS 2006–022)

High Pressure, High Temperature

High-pressure, high-temperature (HPHT) development is the greatest technological and regulatory challenge to the oil and gas industry today. The basic building blocks of structural integrity are being challenged. Metals and elastomers that have been in use for many years now face unique environmental conditions. MMS is working with industry to evaluate the risks and set limits to mitigate these potential hazards. MMS is also sponsoring research and participating in internal and industry-related conferences to stay at the forefront of new technology and is actively involved in developing options that will best promote human safety and environmental integrity. Figures 37 and 38 demonstrate that MMS and industry are already exploring the HPHT condition and illustrate the importance of developing safe, reliable methods of drilling and producing under these harsh conditions. The figures show that, as deepwater wells are drilled to greater and greater depths, they begin to encounter the same HPHT conditions that shallow-water wells see at shallower drilling depths. HPHT compounds the technological

50

challenges faced in deepwater exploration and especially in deepwater completion and production. Consequently, there is tremendous potential for growth and development in the HPHT area.

Technology Enhancement Objectives

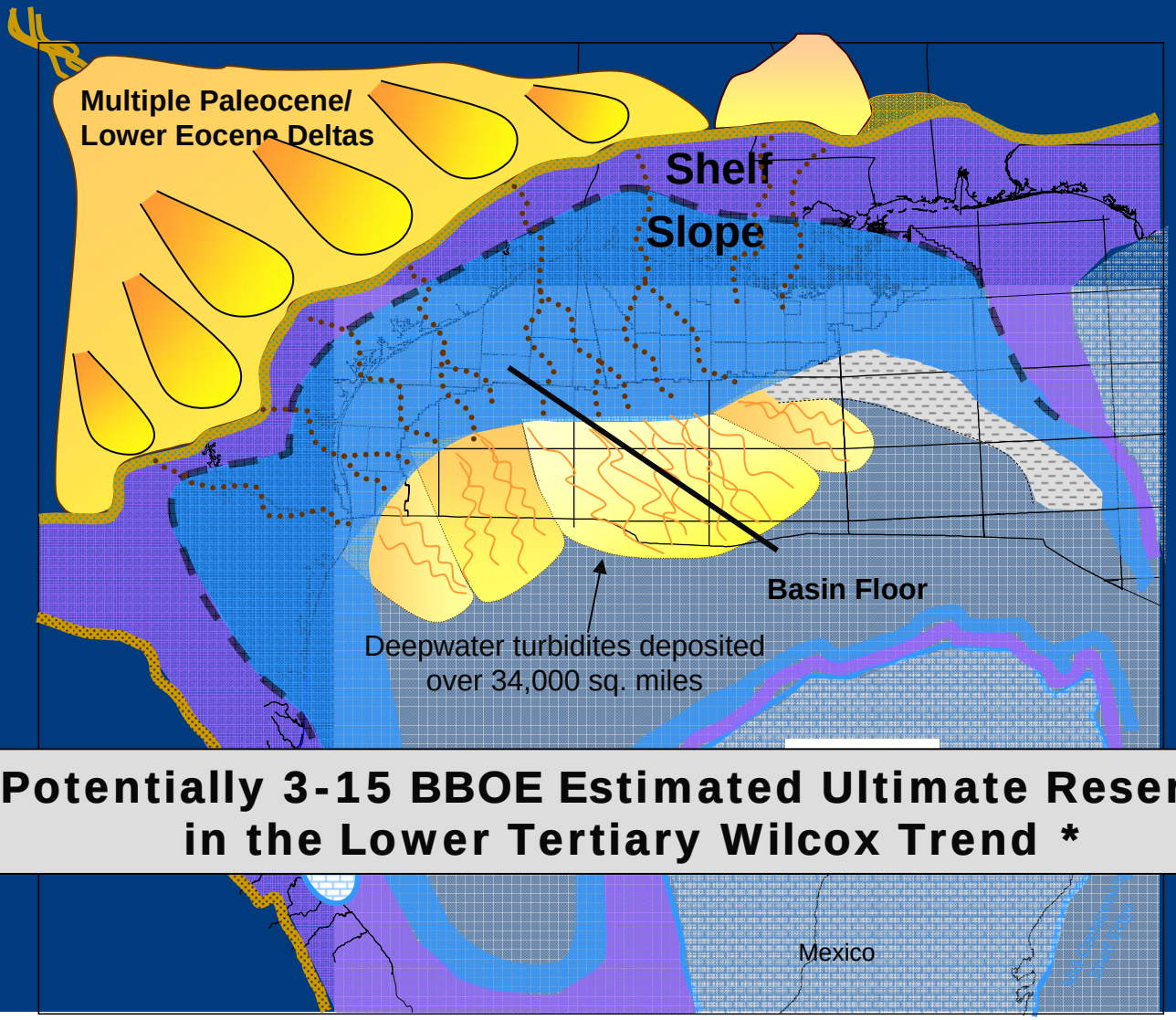
- Identify technologies that can be developed and applied which will have a reasonable opportunity to:
  - reduce the ranges of key uncertainties
  - enhance safe operations and environmental protection
  - lower the investment costs
  - increase production rates
- Any combination of the above ensure the economic success of the commercial development of deep discovered resources

Examples of Technology Enhancement Areas of Interest

- Dual gradient drilling
- Higher pressure subsea pumps
- Completions
  - Multi-frac packs
- MET Ocean understanding
  - CFD in hydrodynamic applications
  - Spar VIM
- Flow assurance capabilities; dynamic modeling
- Subsea separation
- HIPPS technology
- Subsea pumping
- Disconnectable FPSO technology
- Long distance transport
- Risers (esp. HPHT)
- Deepwater anchors
- Raw seawater injection
- Compact processing equipment

Emerging Lower Tertiary Trend:

Schematic Depositional Model for Lower Tertiary Wilcox

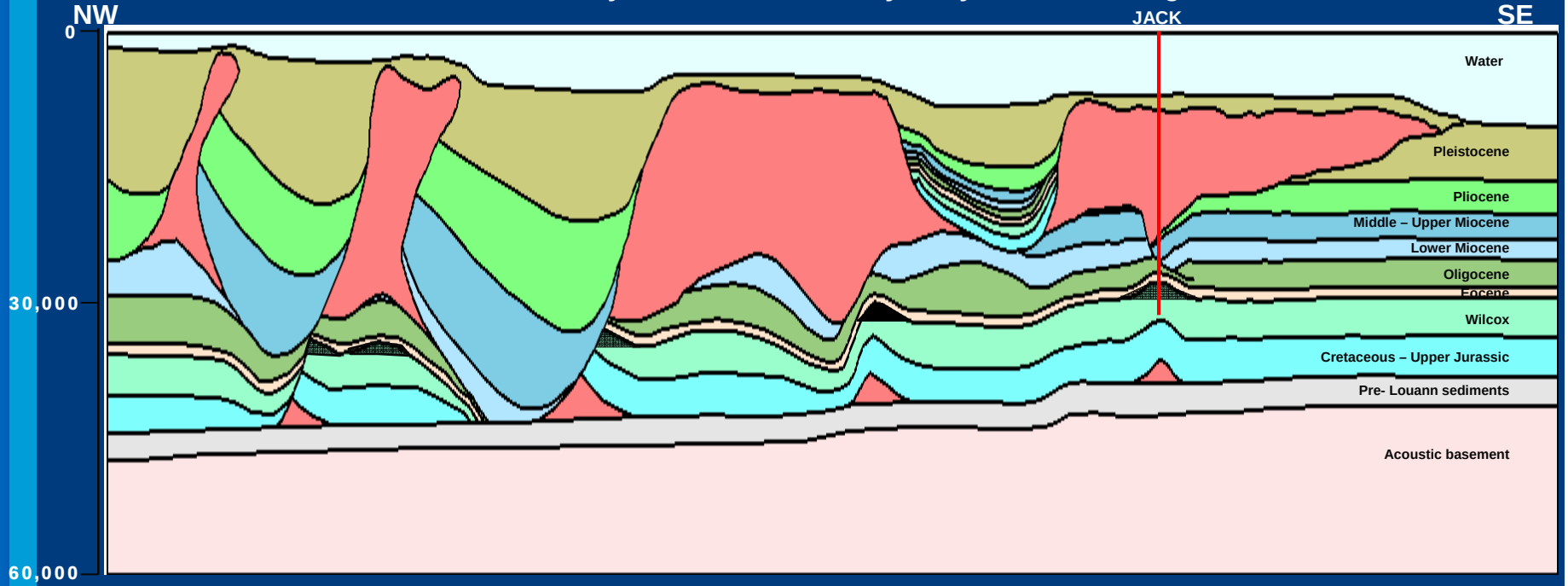


Potentially 3-15 BBOE Estimated Ultimate Reserves in the Lower Tertiary Wilcox Trend *

*** Source: World Oil (May 2005)**

The Emerging Lower Tertiary Wilcox Trend

Schematic x-section of Lower Tertiary Play Types



Salt Ridges, Turtles, and Feeders

Garden Banks
> 32,000′ SS

Salt Feeders / Welds

Central & Northern KC
29,000′ – 32,000′ SS

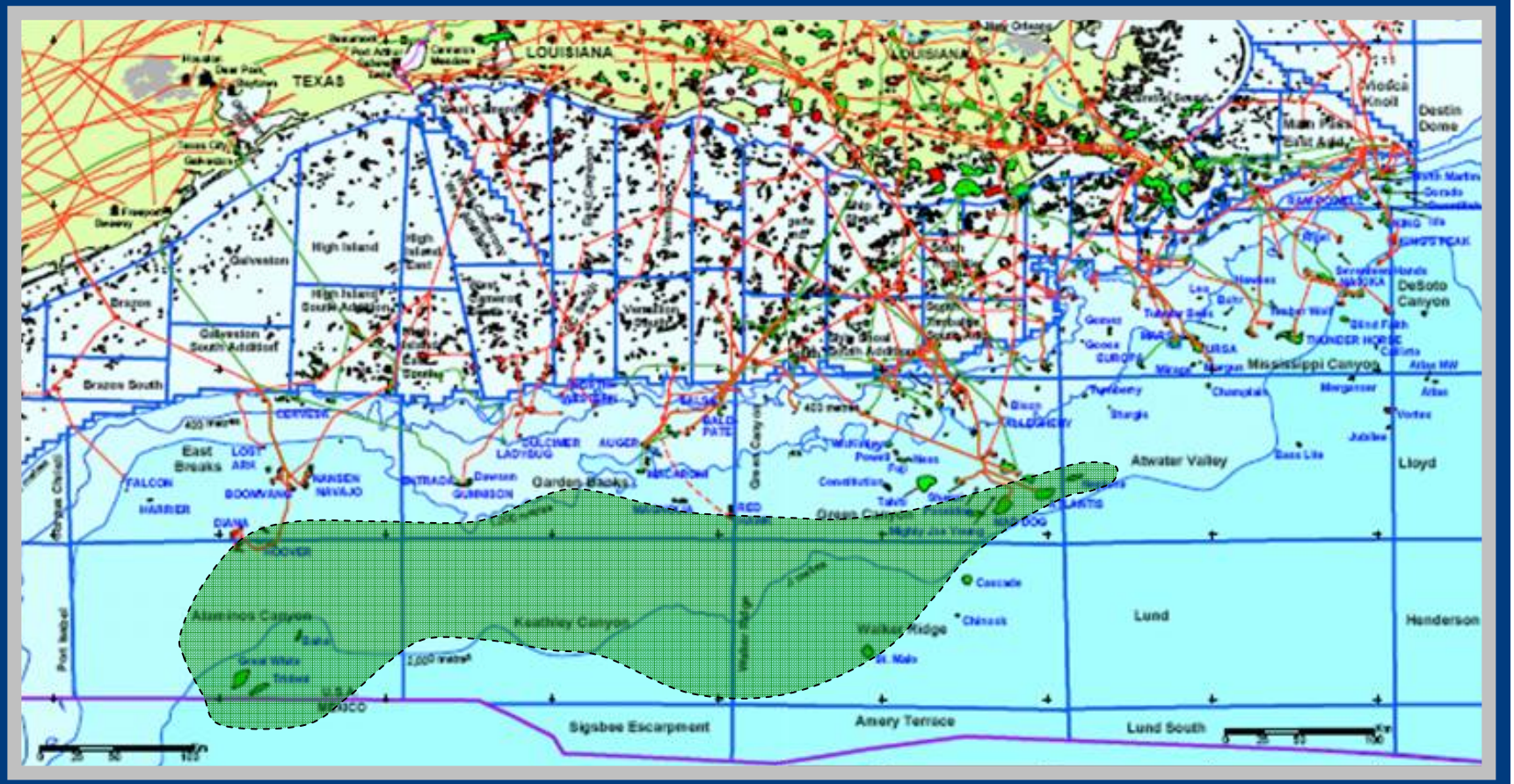
Salt Ridges

Central & Northern KC/WR
28,000′ – 31,000′ SS

Basin Edge Foldbelt

Southern & Western KC
25,000′ – 28,000′ SS

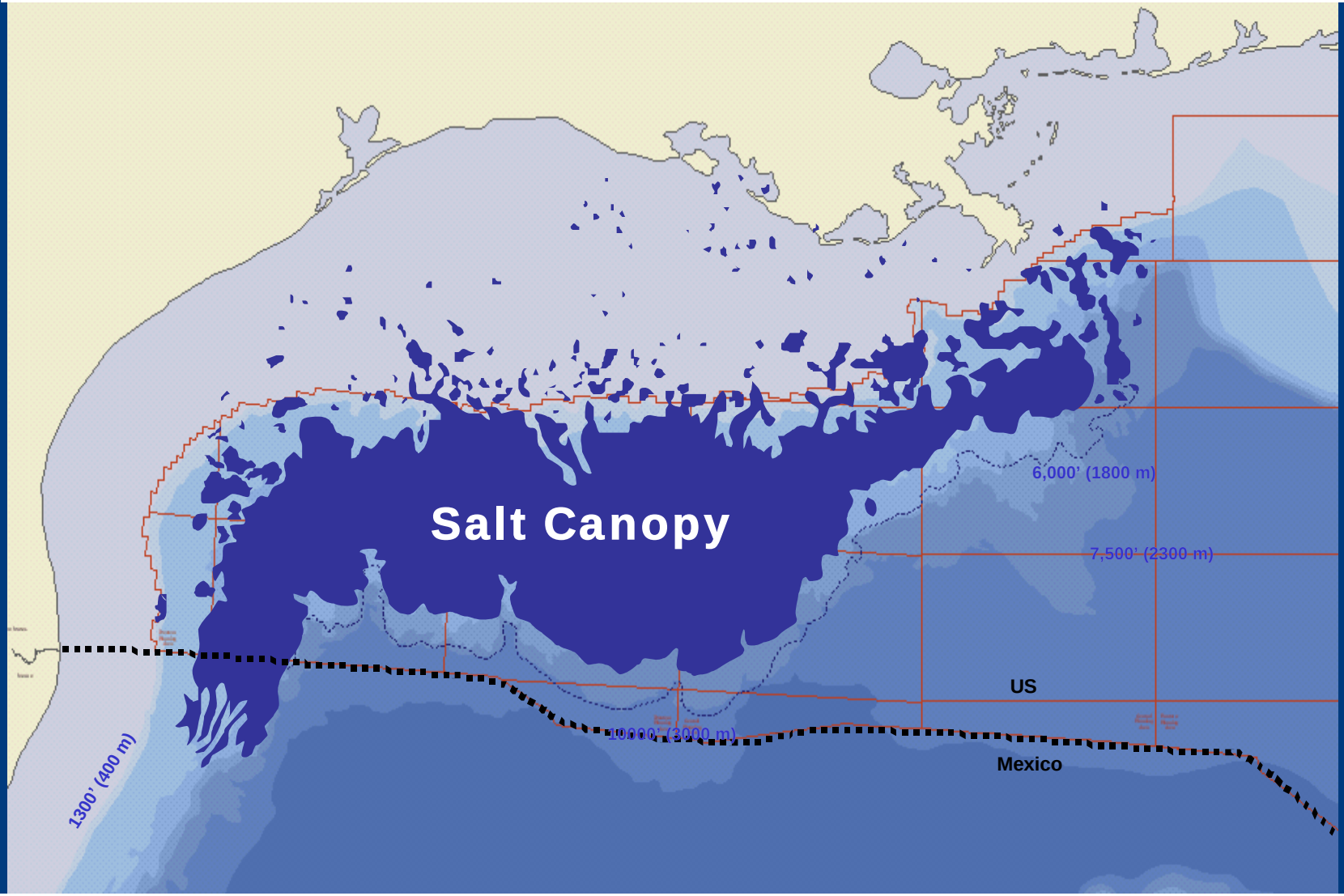
Emerging Lower Tertiary Trend:
Expansion of the Wilcox Trend Potential



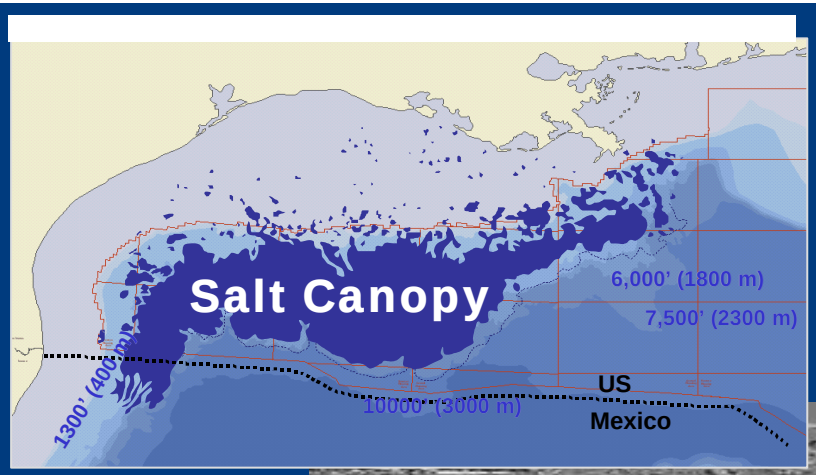
Industry trend results report approximately 70% exploration success rate in the Deepwater Wilcox Trend

Base map source: Wood Mackensie

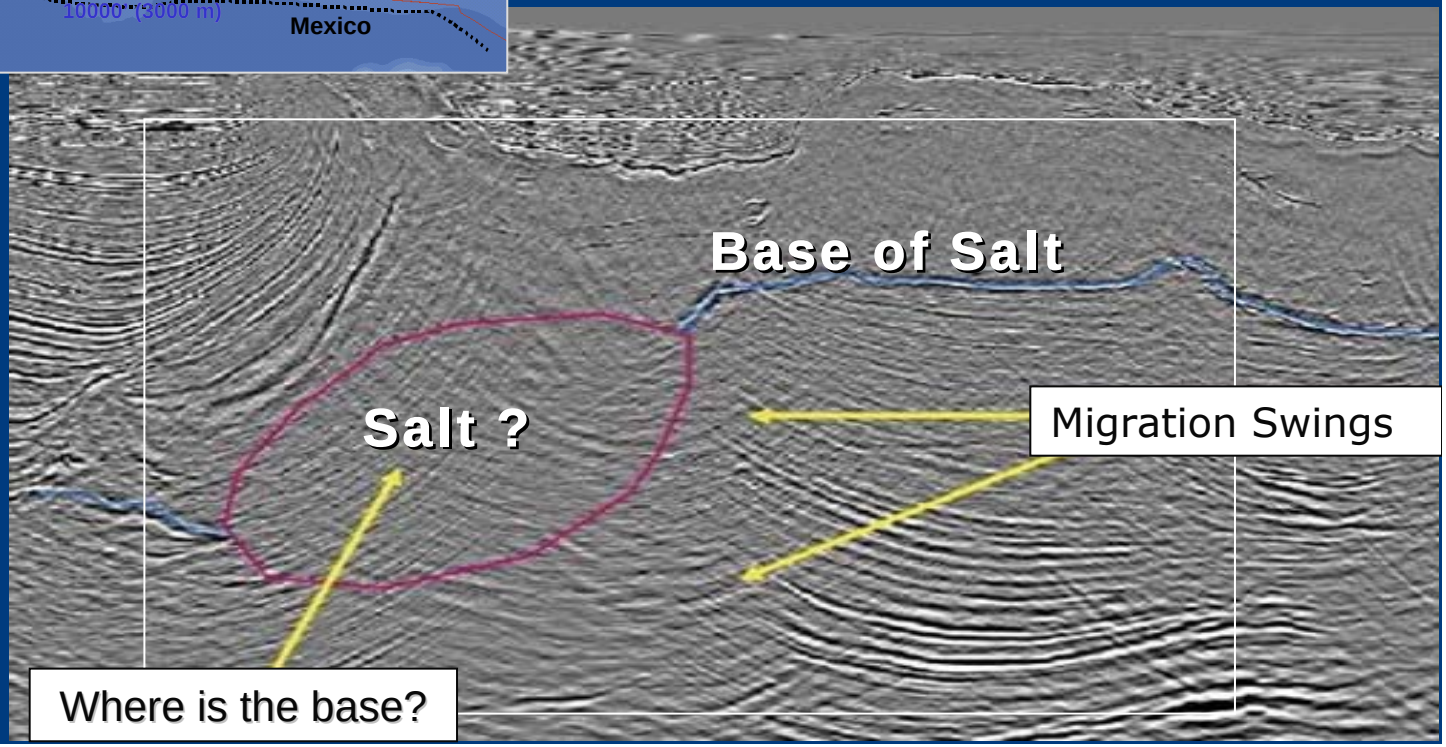
Deepwater Gulf of Mexico
Technically Challenging Environment



Complex Seismic Imaging Environment



Much of the prospective Gulf of Mexico deepwater area is covered by layers of massive salt, which inhibits deeper seismic resolution.



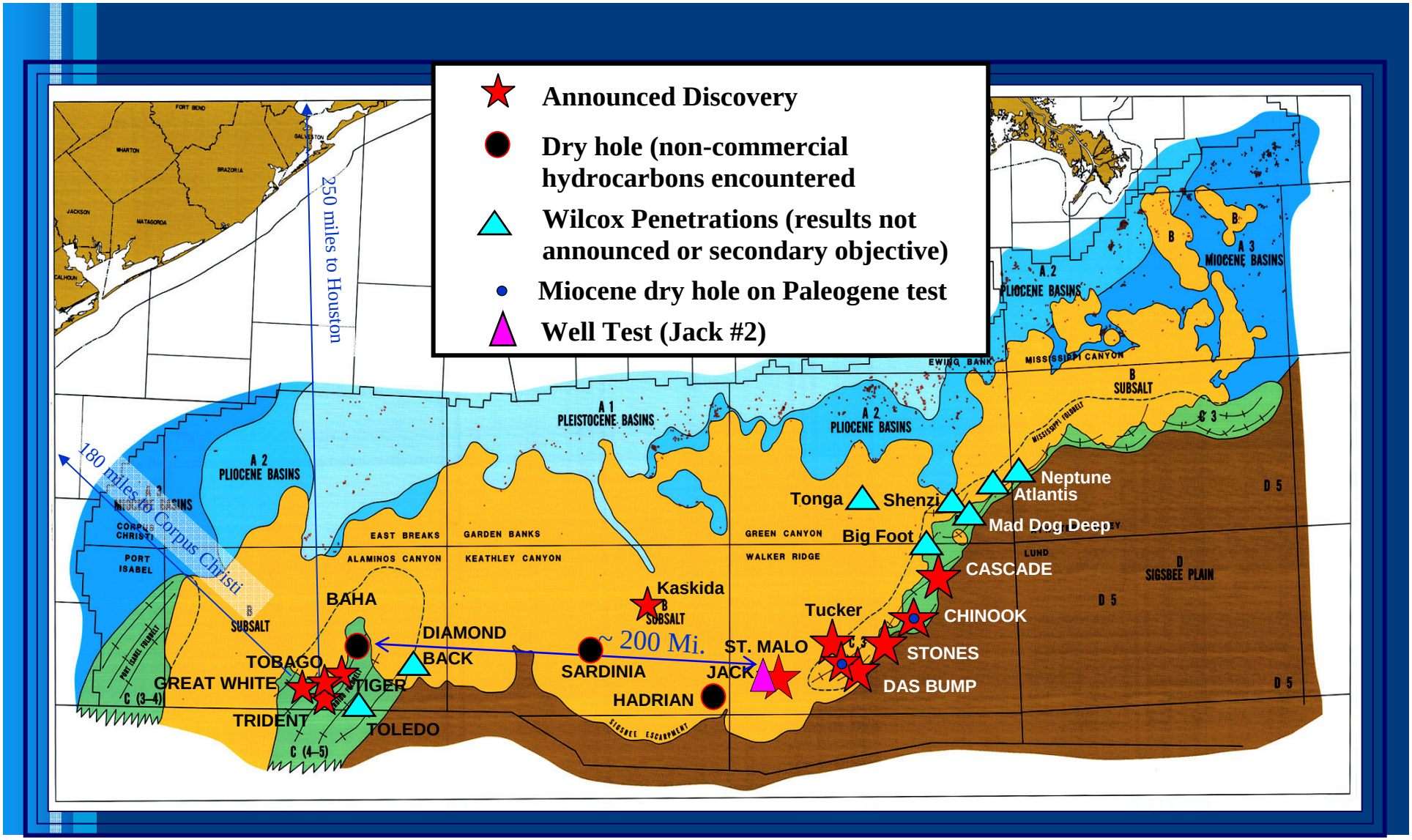
Meeting Deepwater Challenges

Critical Technologies

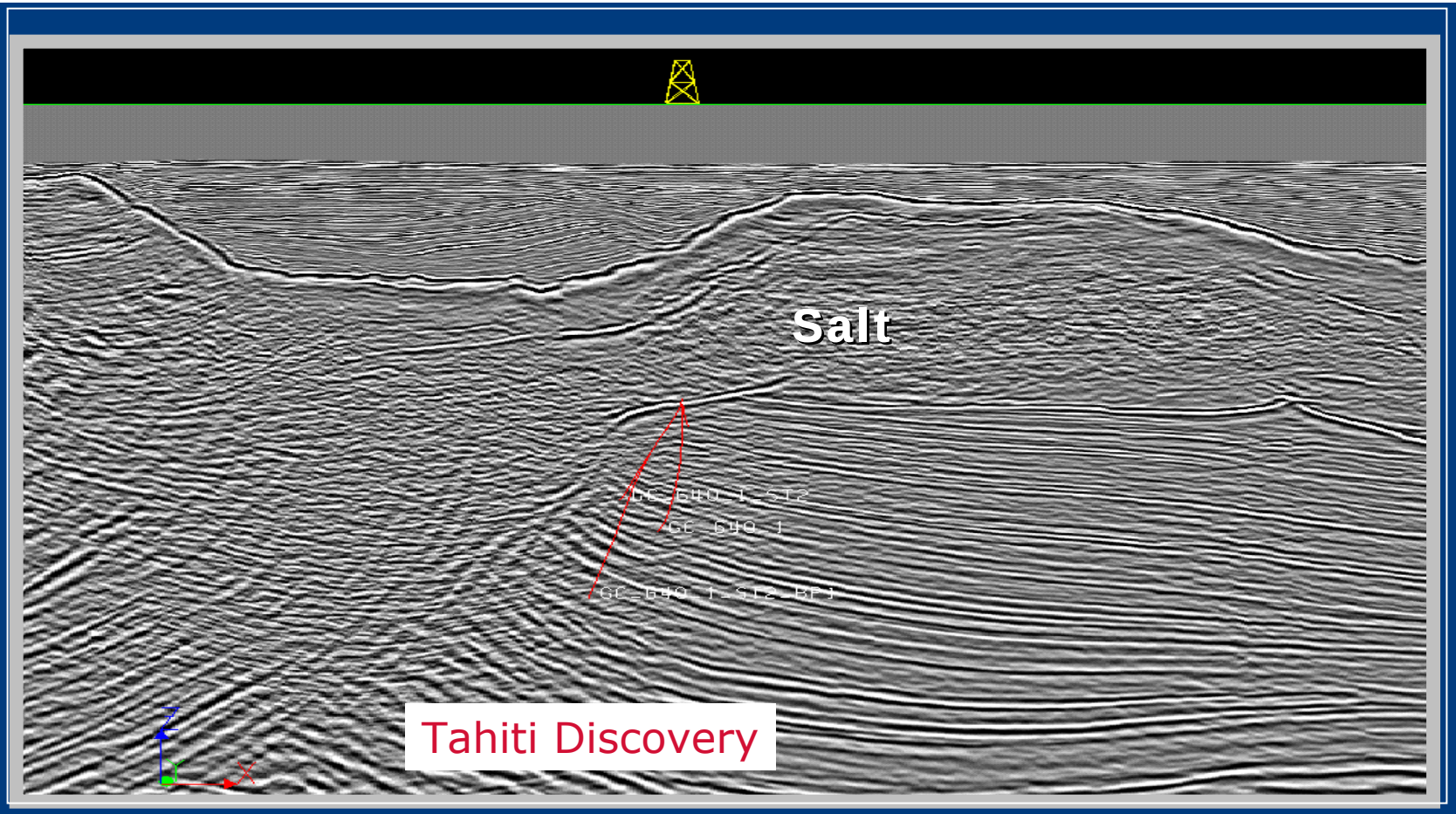
Challenge	Technology
Water Depths Range from 5,000 to 10,000’	Complex Sub Salt Imaging: Seismic Acquisition and Processing
Majority of Play in Sub Salt Environment	Cost Effective Drilling and Completion
Salt Canopies Range from 7,000’ - > 20,000’ Thick	Facility / Infrastructure Design
Target Depths Range from 12,000’ – 35,000’ Subsea	Reservoir Architecture, Quality, and Flow Capability

Wilcox Deepwater Wildcats

Summary as of November, 2006

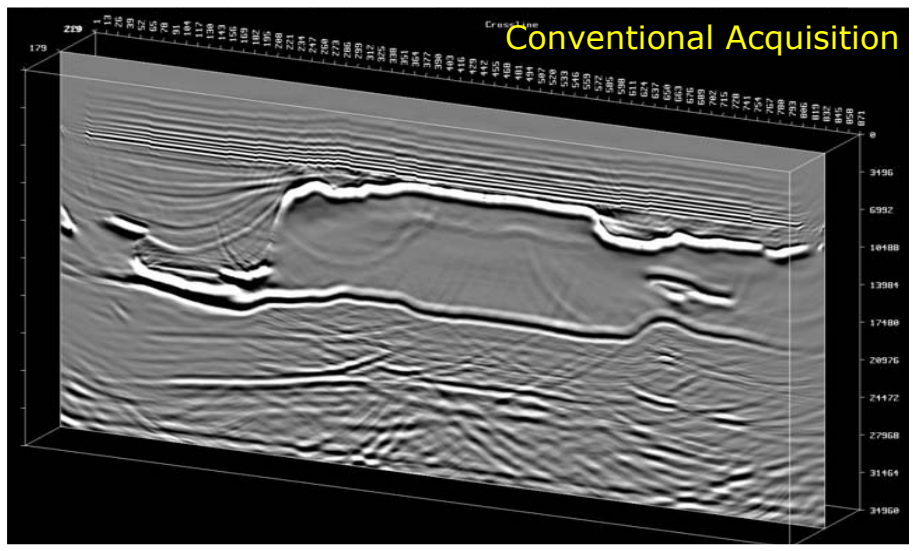


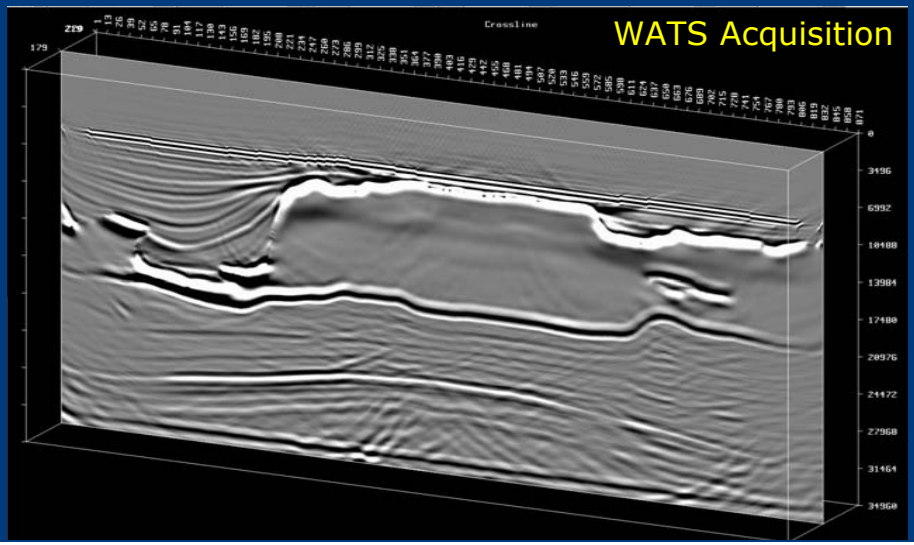
Complex Subsalt Imaging:
Improved images are game changing



- Superior images significantly reduce risk
- Wide-spread applications

Deepwater Technology Breakthrough:
Wide Azimuth Towed Streamer Acquisition (WATS)





Key Issue

Poor quality seismic image below salt

Method and Opportunity

Step-change in image quality

- Wide-azimuth acquisition
- Multiple boats and passes
- Improved illumination
- Multiple suppression

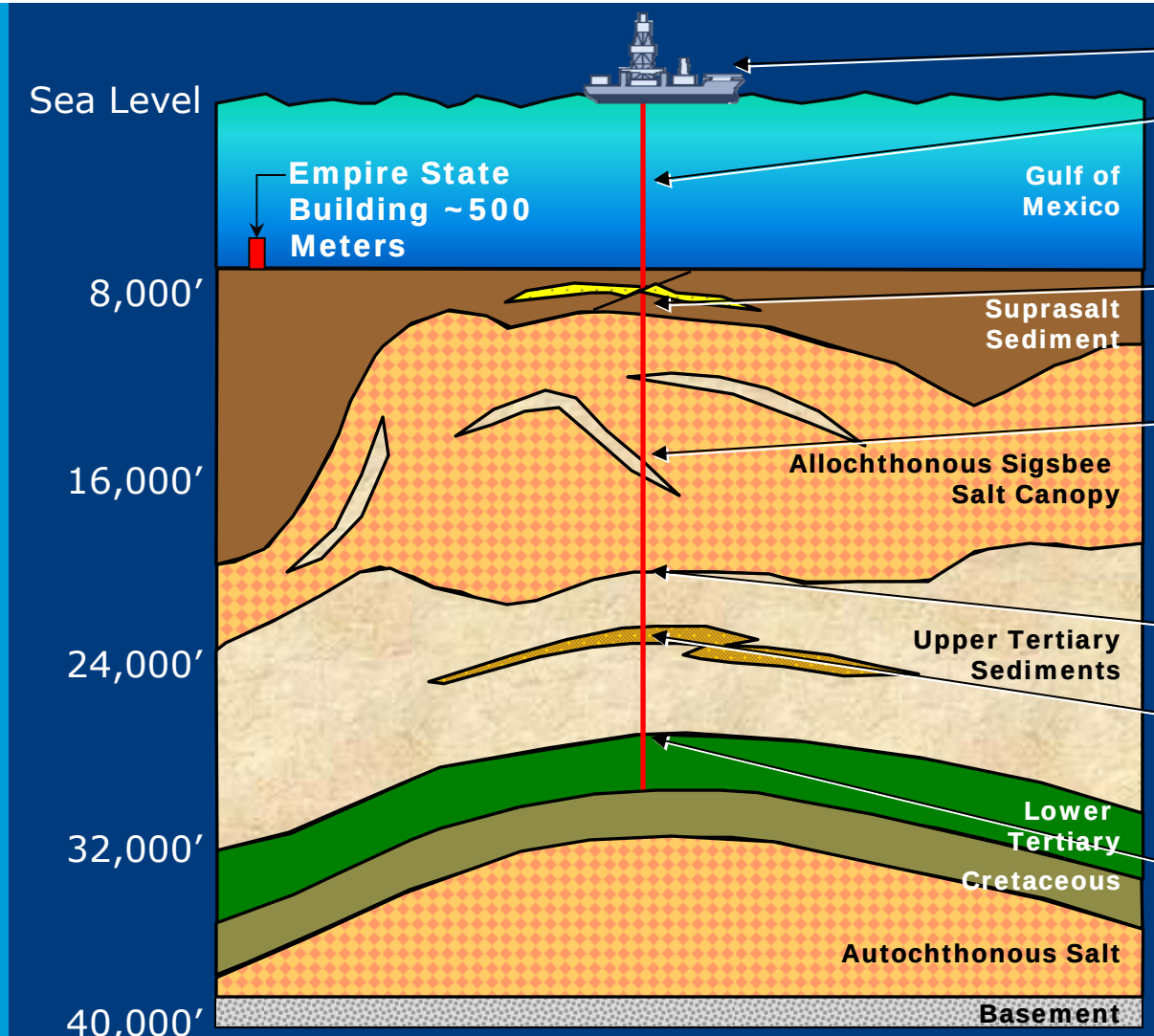
Subsurface Objectives

High quality subsurface image

- Fault identification
- Structure definition
- Delineation of Wilcox zones
- Development well planning

Ultradeep Water Gulf of Mexico

Drilling Technical Challenges



Storms and hurricanes

Loop and eddy currents cause vortex induced vibrations and motions to drill strings

Unpredictable high pressure gas charged stringers and faults near surface

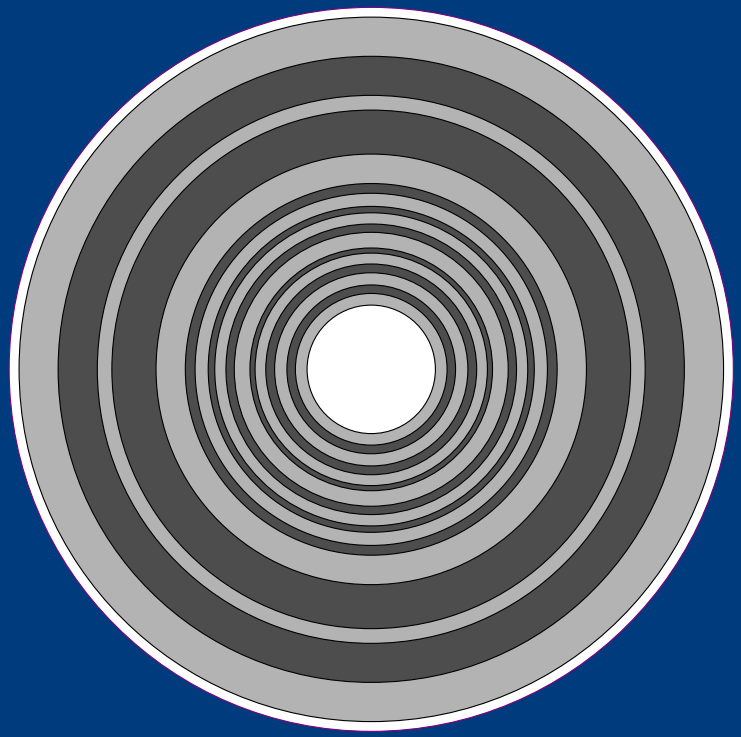
Mobile/flow-able/dissolvable 10,000' thick salt canopy with unpredictable layers of highly variable trapped sediments

Unpredictable base of salt – rapid pressure differentials

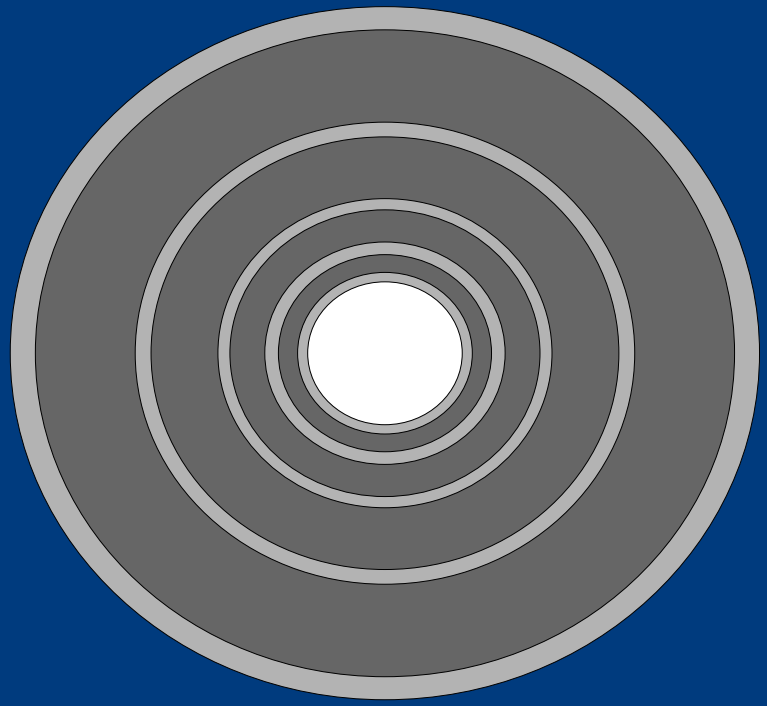
"Thief zones" of significantly lower pressure which cause lost circulation – fluid loss

Ultra-deep reservoir with high temperatures, high pressures and low natural flow-ability

GOM Deepwater Well Complexity
A Bird's Eye View



Gulf of Mexico Deepwater
Casing Program:
36" – 7 3/4"

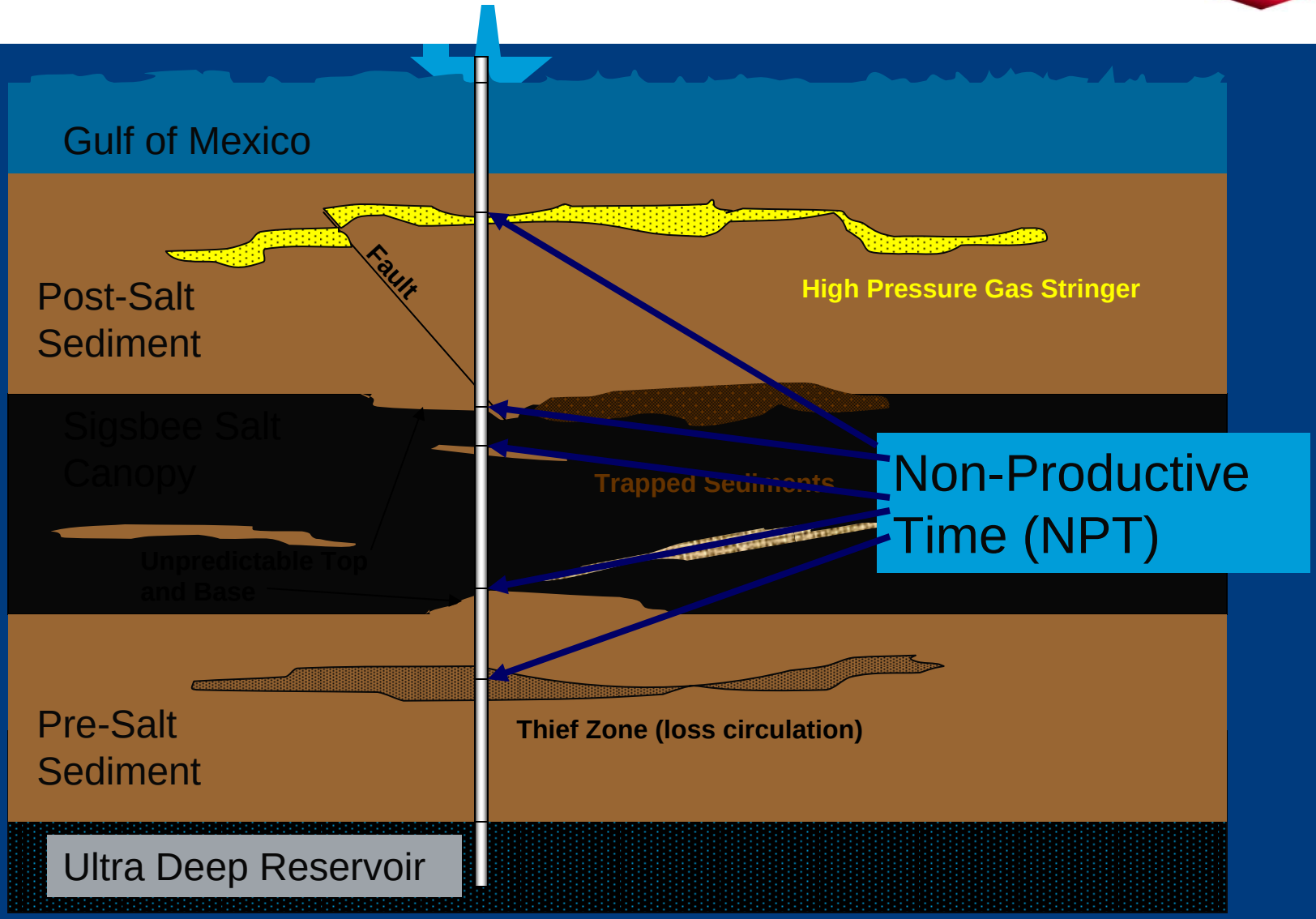


Conventional Deepwater
Casing Program:
30" – 7"

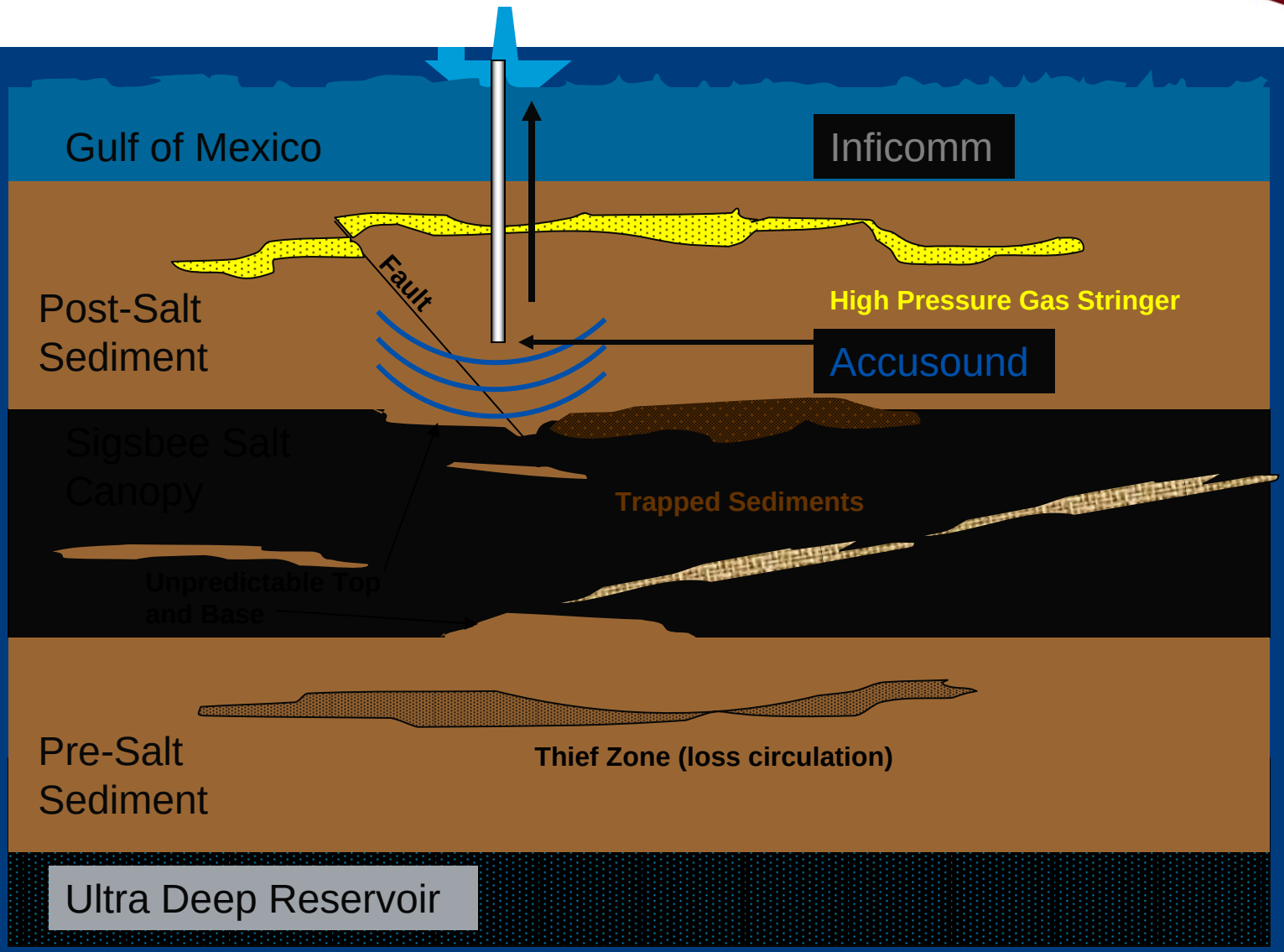
Well Construction
Sonic Bit Monitoring (Accusound & Inficomm)

- Advance preparation for operational changes that mitigate non-productive time (NPT) encountered above, within and below the Sigsbee salt canopy
- Capture and transmit high frequency acoustic signatures from the drill bit to the surface in real-time
  - Sonic signature measures bit/bearing wear, actual weight on bit, and formation changes developed by Accusound
  - Transmission to surface using a new electromagnetic pulse (EMP) technology commercially developed by Inficomm

Sonic Bit Monitoring



Sonic Bit Monitoring

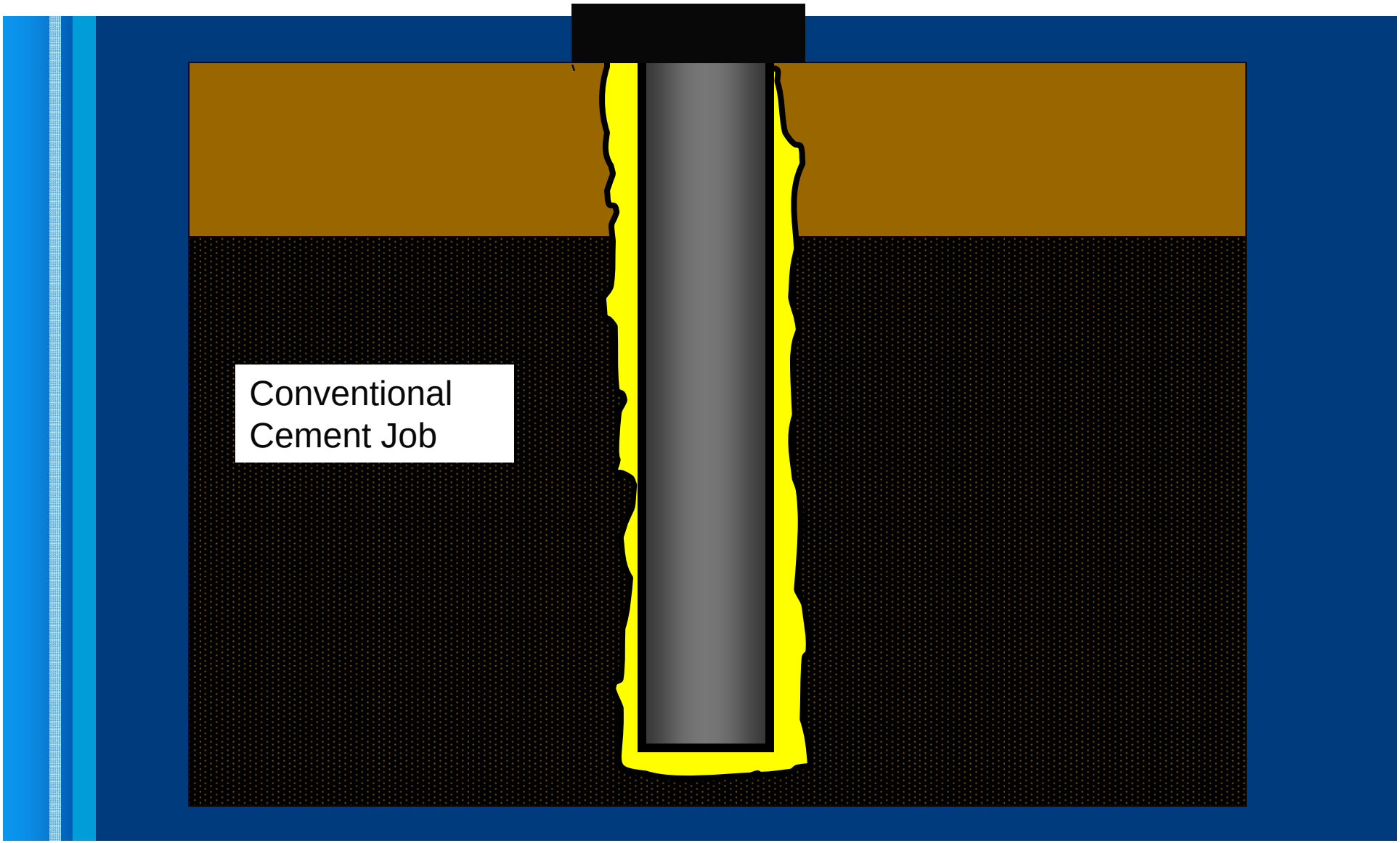


Well Construction

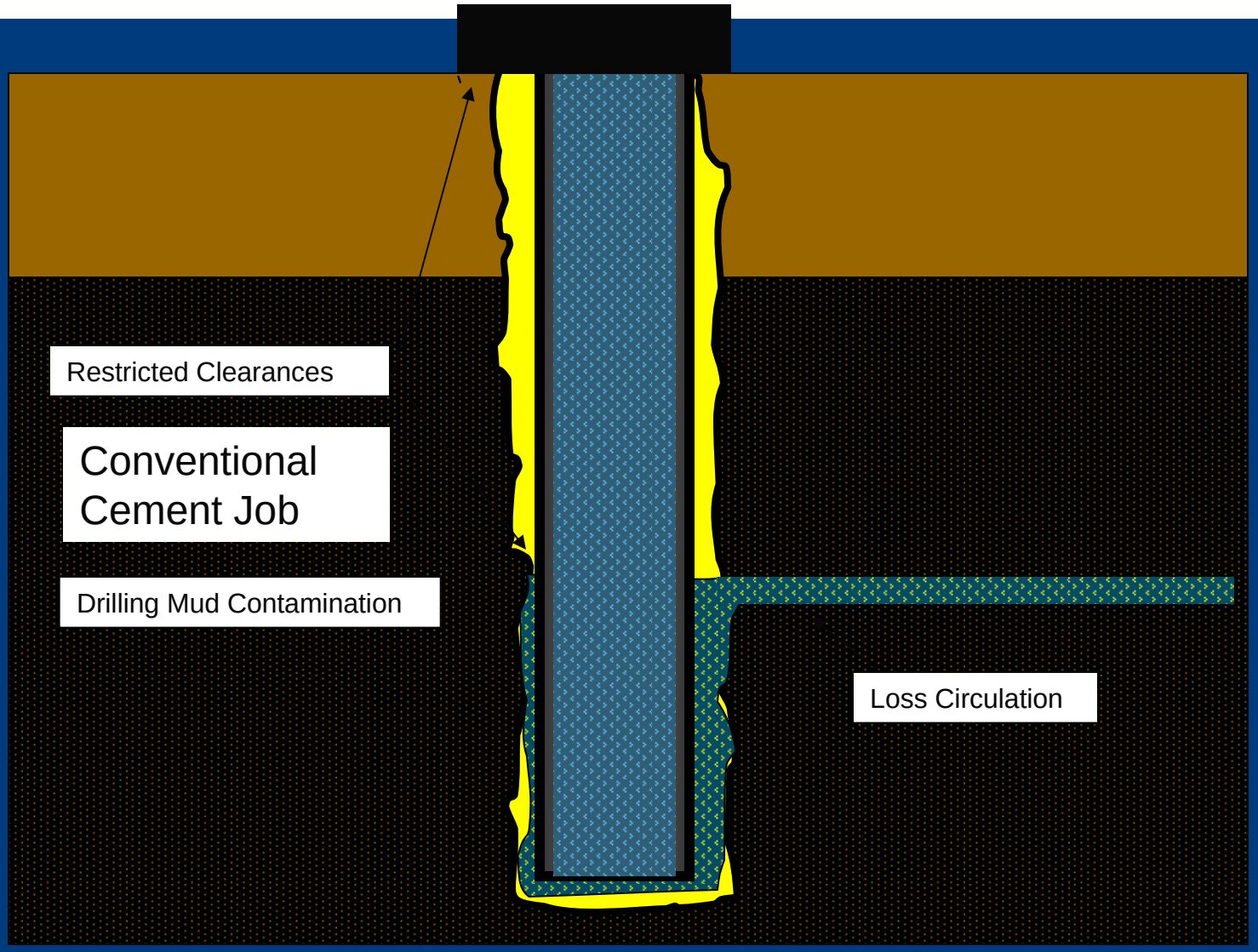
High Strength, Light Weight Cements

- Geo-polymer and graphite reinforced light weight cements with very high strengths and very low permeability
- New cements could:
  - minimize the effects of lost circulation zones
  - drilling mud contamination
  - problems associated with placement techniques

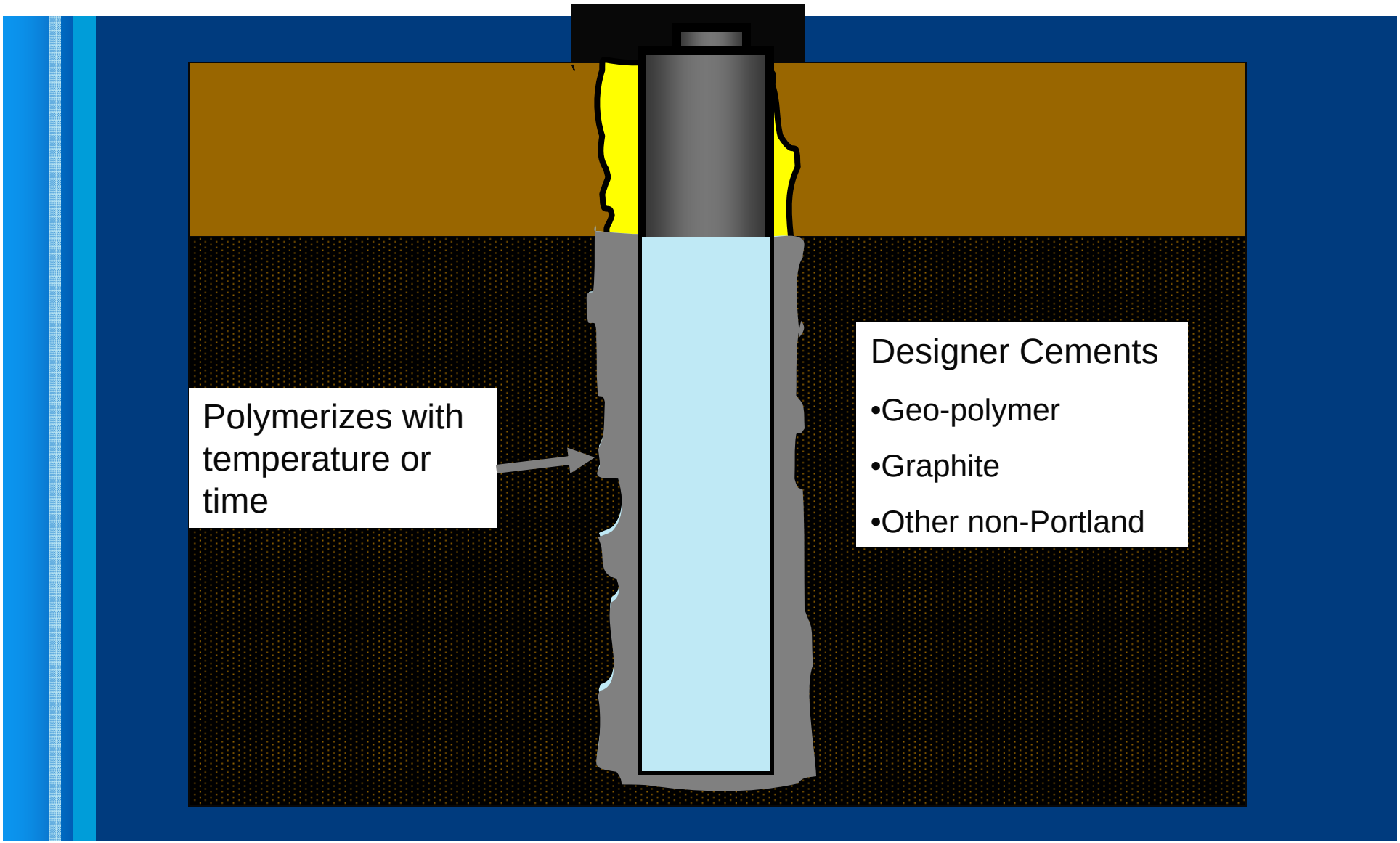
High Strength, Light Weight Cements



High Strength, Light Weight Cements



High Strength, Light Weight Cements

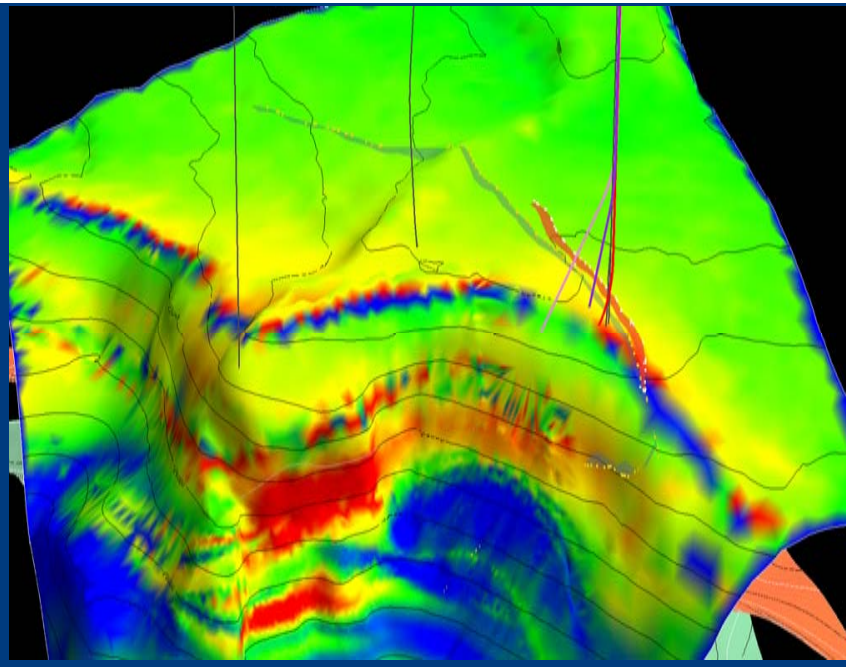


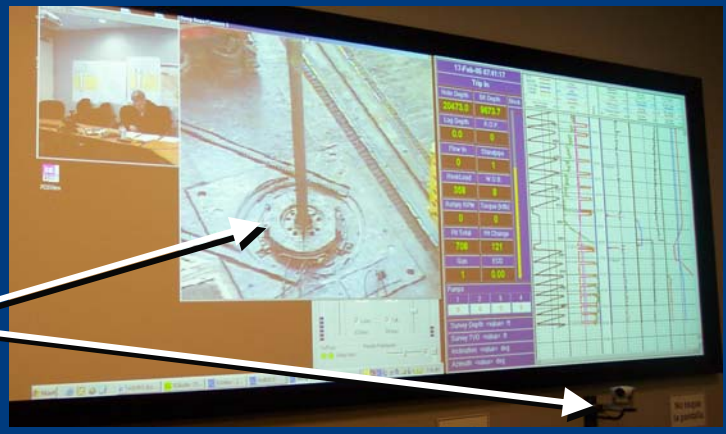
Effective Drilling and Completions
Optimizing Performance

Drilling and Completions Technology

Integrated technology solution

- Seismic imaging
- Reservoir modeling
- Rock mechanics
- Drilling operations
- Real-time monitoring





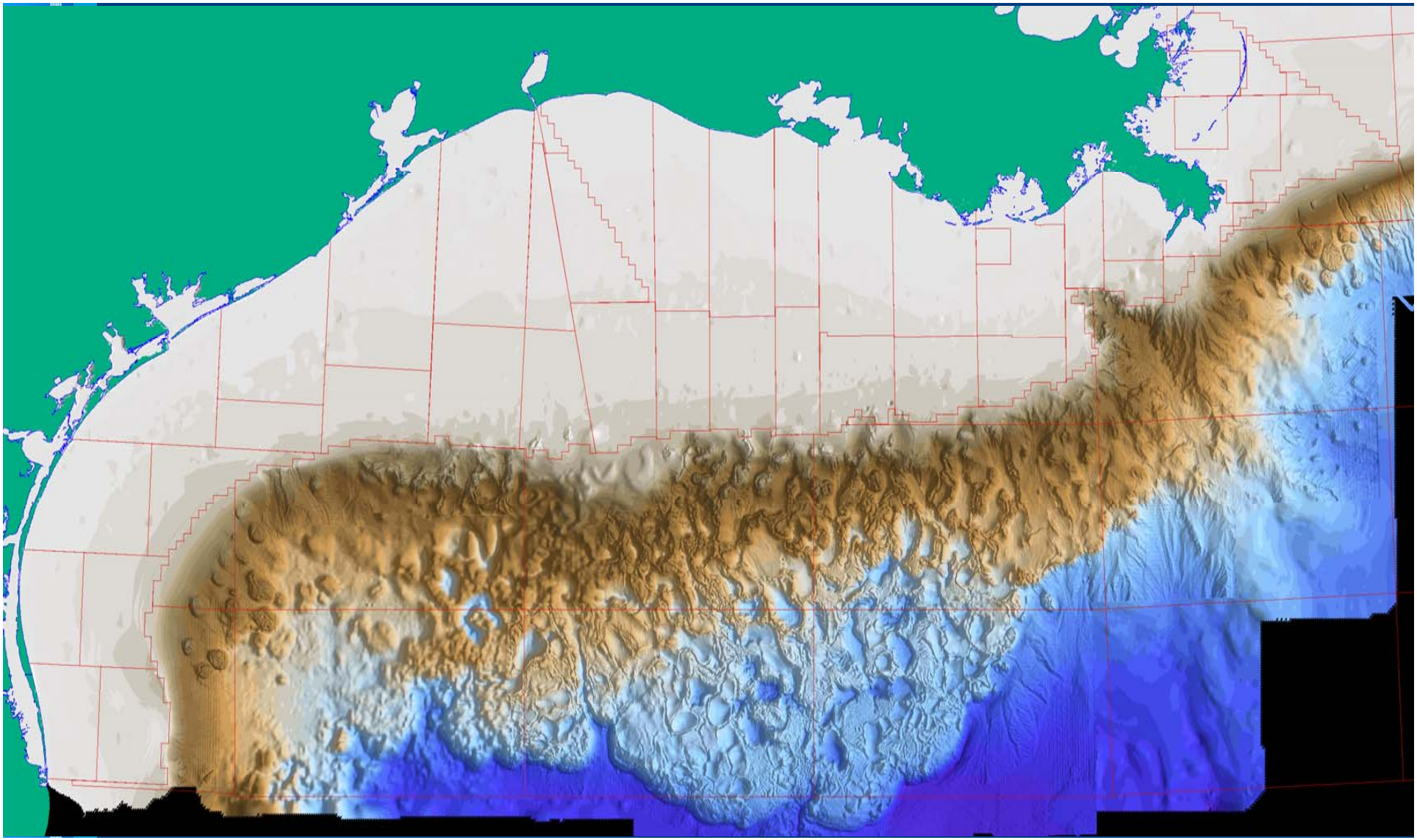
(Live video camera and feed from rig)

Effective Drilling and Completions

Dual Gradient Drilling Technologies

- Managed Pressure Drilling package and Lower Marine Riser package being installed on the BOP
- Unit is deployed on the Seabed
- System allows Dual Gradient Drilling

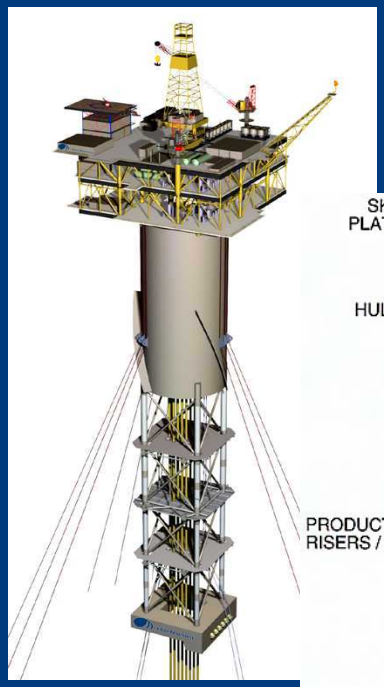
Gulf of Mexico Seafloor Bathometry

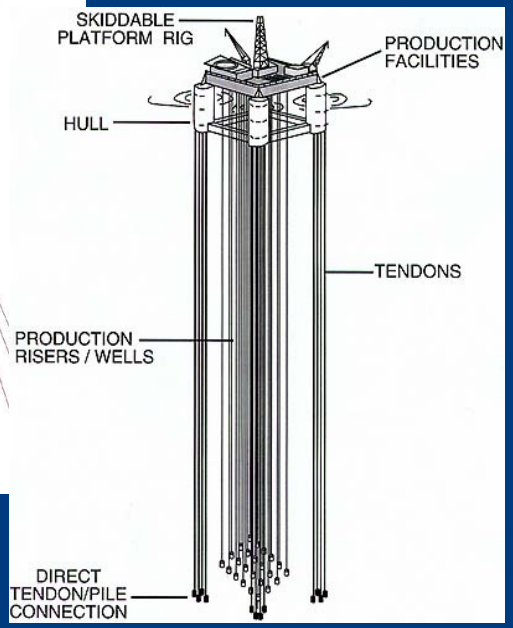


Floating System Concepts

Dry Tree Solutions

Tension Leg Platform
- −Weight sensitive
- −Depth limited





Spar
- −VIM effects
- −Suppliers limited

Wet Tree Solutions

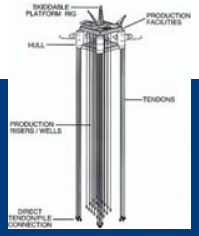
Semi-Submersible
- +Quayside integration
- −Riser fatigue

FPSO
- +Storage capacity
- +Quayside integration
- −Riser interface
- −Riser fatigue

Water Depth Comparison

Spar

- Genesis
- Tahiti
- Mad Dog
- Devil's Tower



TLP

- Hutton
- West Seno
- Magnolia

Semi

- Troll
- Thunder Horse
- Na Kika
- Blind Faith
- Independence Hub

FPSO

- Captain
- Girassol
- Agbami
- Seillean

Water Depth (m)

0

1,000m

2,000m

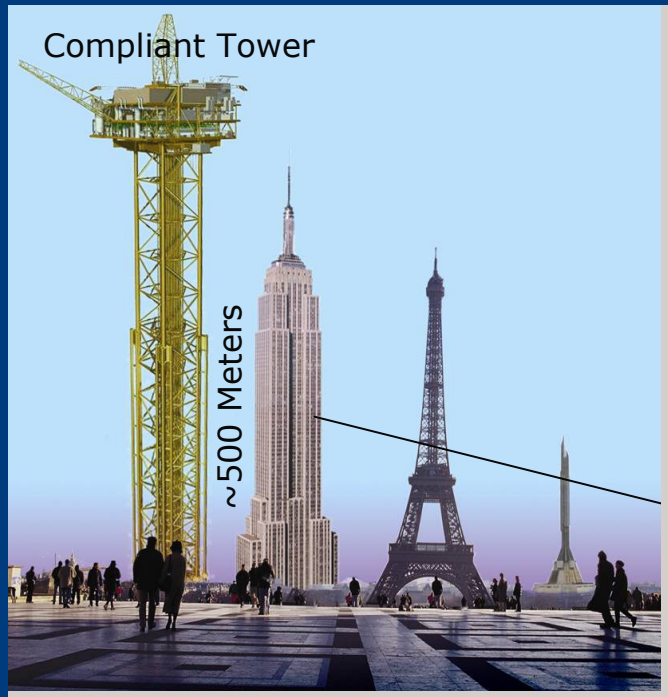
3,000m

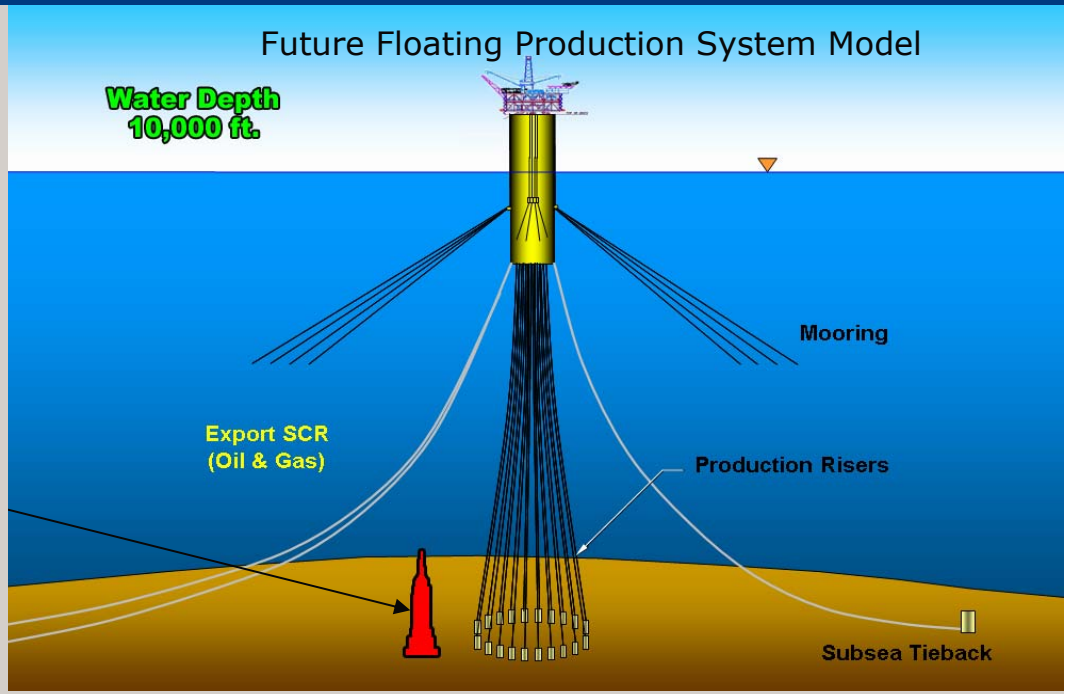
Field Proven

Technology qualified

Deepwater Facilities / Infrastructure

Meeting Future Technology Challenges





- Ultra Deepwater Development
- Reliability – Surface, Risers & Export Systems
- Reliability – Subsea Systems
- Flow Assurance
- Long Distance Subsea Tiebacks
- Subsea Intervention Cost Reduction
- Small Field Development Systems
- Standard Concepts – FPSO's
- Standard Regional Subsea Equipment
- Life-Cycle Water Management

Cost, Schedule, and Technical Challenges

- Higher Pressure & Temperature
- More Difficult Reservoir Fluids
- Longer Tie-back Distances
- Remote Areas with Little Infrastructure
- More Engineering, Manufacture & Fabrication done in Host Countries
- Industry has More Deepwater Projects Underway than ever before
- Suppliers have Full Order Books
- Extreme Competition for Limited Manpower and Supplier Resources

Deepwater Facilities: Key Investment Areas

- Ultra Deepwater Development
- Reliability – Surface, Risers & Export Systems
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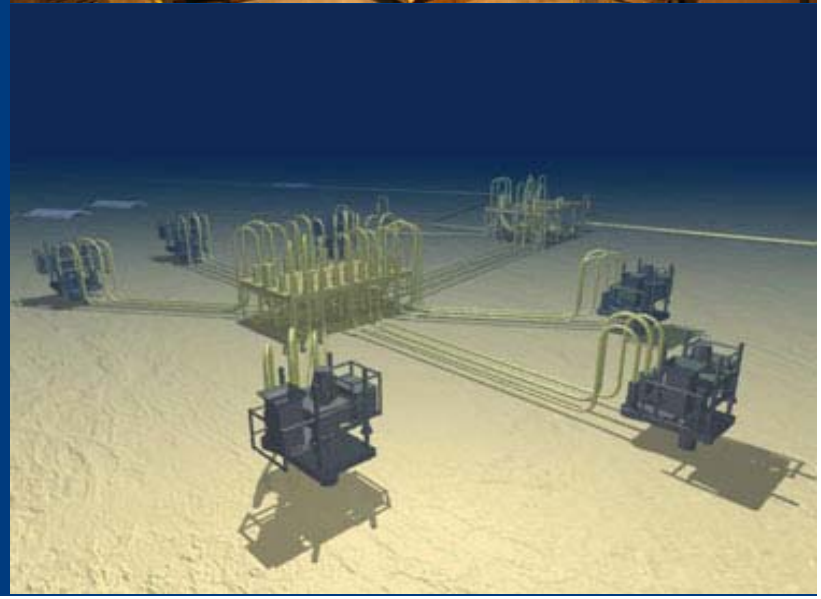
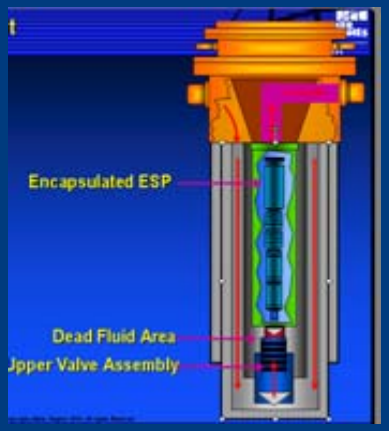


Subsea & Pipelines

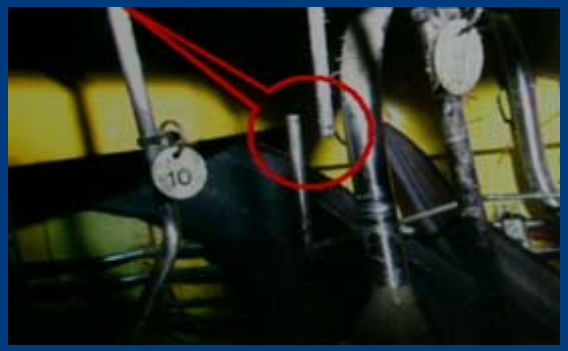
- Qualify seafloor boosting beyond 5000 ft. WD
- Enable long distance tiebacks for satellite field development
- Subsea Reliability – ensure subsea systems operate as designed

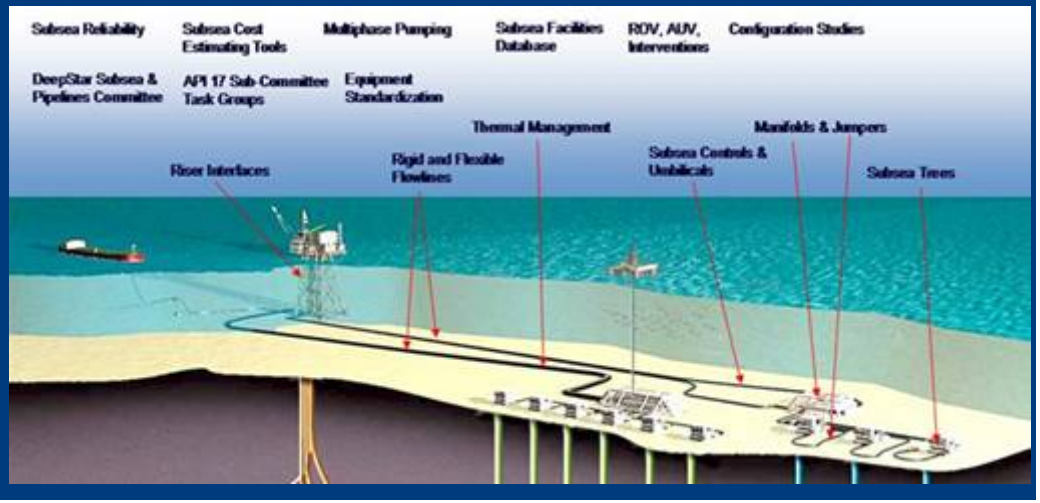


Subsea Pumps

Multiphase Flowmeters

Subsea Electrical Power Distribution





Flow Assurance

- Facility Design Enhancements, Prevention & Remediation
  - Hydrates
  - Wax
  - Scale
  - Asphaltenes
  - Emulsions
  - Corrosion
- "Flow Assurance Unified Simulation Tool" – the next generation for the industry
  - Currently commercializing
  - Complete linkage of CVX proprietary standalone models

The outlook for deepwater includes more technology investment per barrel…

Achieve operational excellence

- **Environmental**
- **System reliability**

Advance drilling and completion technology

- **Maximize recovery from single wellbore**
- **Reduced intervention costs**

Visualize and model the subsurface

- **Real time**
- **Earth modeling**
- **Reservoir characterization**

Research and Development

- In-house Technology Development
- Vendor Technology Development
- Academic (University) Technology Development
- Los Alamos National Laboratories
- Technology Joint Ventures

Sec. 250.175 When may the Regional Supervisor grant an SOO?

(a) ….. when necessary to allow you time to begin drilling or other operations when you are prevented by reasons ***beyond your control***, such as unexpected weather, unavoidable accidents, or drilling rig delays.

(b) ….. when all of the following conditions are met: (1) The lease was issued with a primary lease term of 5 years, or with a primary term of 8 years with a requirement to drill within 5 years; (2) Before the end of the third year of the primary term, you or your predecessor in interest must have acquired and interpreted geophysical information that indicates: (3), (4) & (5)

(c) ….. to conduct additional geological and geophysical data analysis that may lead to the drilling of a well below 25,000 feet true vertical depth below the datum at mean sea level (TVD SS) when all of the following conditions are met:(1), (2), (3) & (4)

Proposed New Language

250.175(d)

The Regional Supervisor may also grant an SOO when **all** of the following are met:

- prior to the expiration of the primary term, you have commenced the drilling of a well, or have drilled a well on the lease;
- the well drilled is determined to be producible according to 250.115 or 250.116;
- the discovered hydrocarbon bearing formation contains resources in amounts believed to be sufficient to develop if:
  - a production test of the hydrocarbon bearing sand or sands yields significant information to calculate volumes which could be used to justify further development; or
  - equipment is needed to be developed, or substantially modified, to allow the discovered resources to be produced; or
  - enhanced processed geophysical data substantiates the belief sufficient hydrocarbons exist to justify development.

(4) When requesting a suspension under this 250.175(d), you must submit a reasonable schedule of work detailing the specific action you will take leading to your commitment to develop the resource discovered.

Summary

- Many technical challenges have already been solved, but more are on the horizon as the water gets deeper and costs continue to grow
- Need to utilize different development models and technologies for each project – there is no one size fits all
- Significant investments in many new deepwater technologies will be needed to economically develop future opportunities

Questions ?????