# Advanced Exploration Technology and Concepts – Key to Future U.S. Gulf of Mexico Deep Shelf Oil and Gas*

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## Abstract

For more than 60 years, the Offshore U.S. Gulf of Mexico has been the "R&D Lab" for the world petroleum industry. Powered by continual development of new geologic depositional and structural models, seismic data acquisition and processing techniques, along with innovations in drilling and completion technologies, the Offshore Gulf of Mexico has repeatedly yielded new plays with world-class oil and gas resources, assuring its permanent place as one of the global super basins for petroleum production.

Over the last 20 years, drilling and regional geologic studies supported by extensive 3D seismic data have proven that most salt bodies in the Gulf of Mexico are part of extensive allochthonous salt sheets that have translated more horizontally than vertically throughout the subsurface shelf and slope. Much of what the mobilized salt has covered are thick, untested sedimentary sections containing reservoir-quality sand bodies and highly effective sealing shales, with preservation of petroleum liquids assisted by the heat-transfer properties of the embedded salt bodies. The industry has confirmed that advanced seismic-imaging technologies, such as broad-frequency Reverse Time Migration, have significantly clarified subsalt and side-salt imaging such that potential traps and even hydrocarbon indicators are far better defined, thereby enhancing future wildcat drilling success.

Economics are extremely robust, benefitting from short production cycle times, advances in drilling and production technologies, access to well-established infrastructure, and reasonable lease bonus costs.

Today, explorers are focusing these technologies and concepts intently on the deep Miocene shelf, where new large oil discoveries will be made. Recent deepwater Miocene subsalt discoveries were built upon the initial pioneering success in the 1990s, e.g., Mahogany, Conger, Hickory and Tanzanite fields. Gone are the days when drilling stopped at the first sign of salt, as in the first 40 years of the Gulf of Mexico exploration. Now, the deep Miocene section under the present-day shelf holds significant petroleum potential for substantial thicknesses of subsalt sedimentary section.

For explorers like us that have spent over 35 years exploring the Offshore Gulf of Mexico, we have always known the Gulf of Mexico to be a world class exploration province with perpetual potential. Those who have spoken of it as the "dead sea" likely underestimated the industry's ability to evolve geologic concepts and develop critical technologies. Billions of BOE are yet to be discovered, enabled by the continuous advances in technologies and geological concepts that the industry always has, and will continue, to develop in its "R & D Lab."

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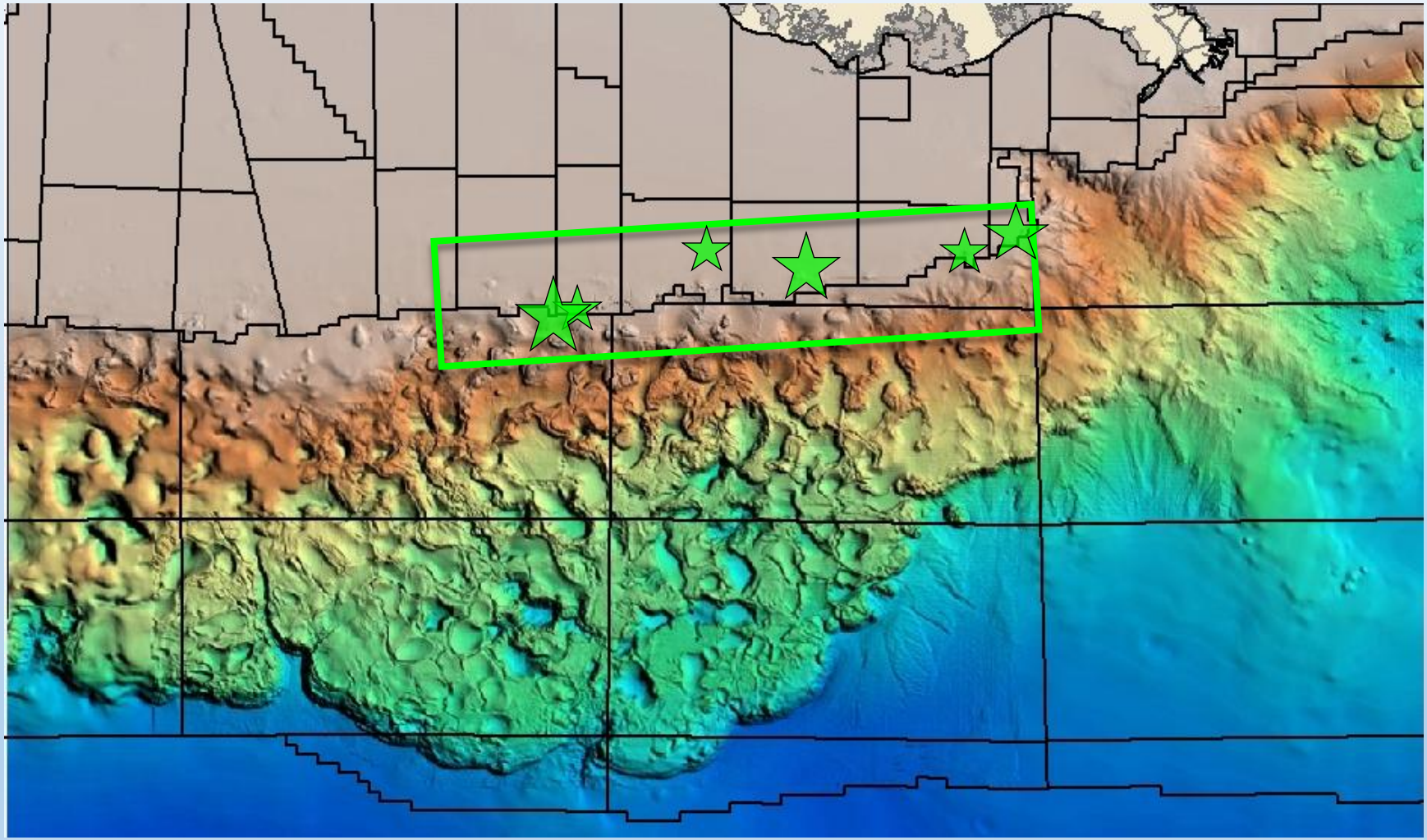
**with Rich Heaney, Bill Lefler, & Tom Uphoff**

GulfSlope Energy

**GCAGS 2014 – Lafayette, LA**
**October 6 2014**

# Shelf Miocene Sub-Salt Play Area



# Exploring a Proven Petroleum System

***400+ MMboe were discovered in the 1990s in the Shelf Miocene Sub-Salt play***

**Conger 240+ MMBoe**

| Discovered | 1St Prod |
|---|---|
| 1998 | 2000 |

**Hickory >45 MMBoe**

| Discovered | 1St Prod |
|---|---|
| 1998 | 2000 |

**Mahogany >45 MMBoe**

| Discovered | 1St Prod |
|---|---|
| 1993 | 1997 |

**Enchilada >30 MMBoe**

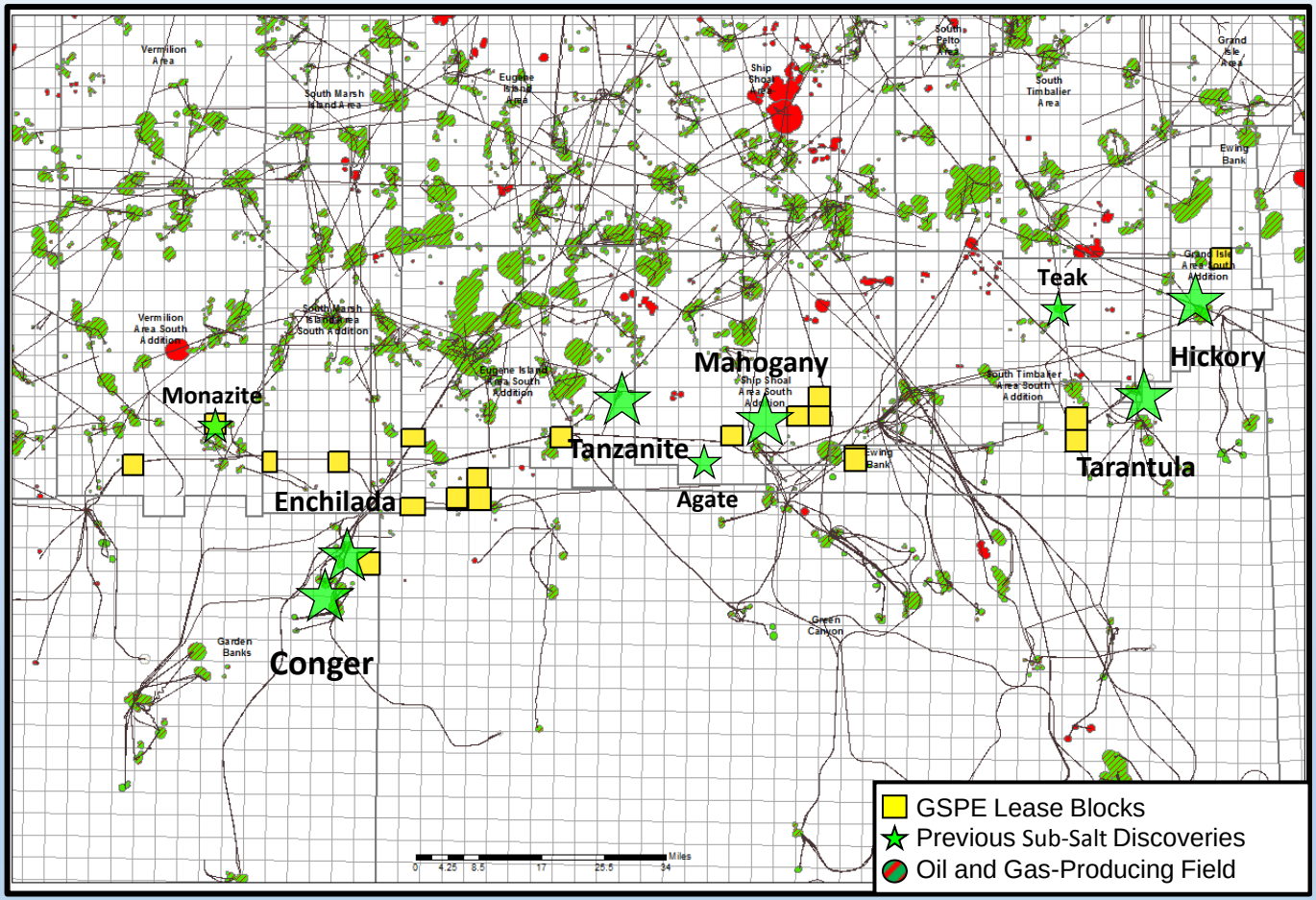
| Discovered | 1St Prod |
|---|---|
| 1995 | 1997 |

**Tanzanite >20 MMBoe**

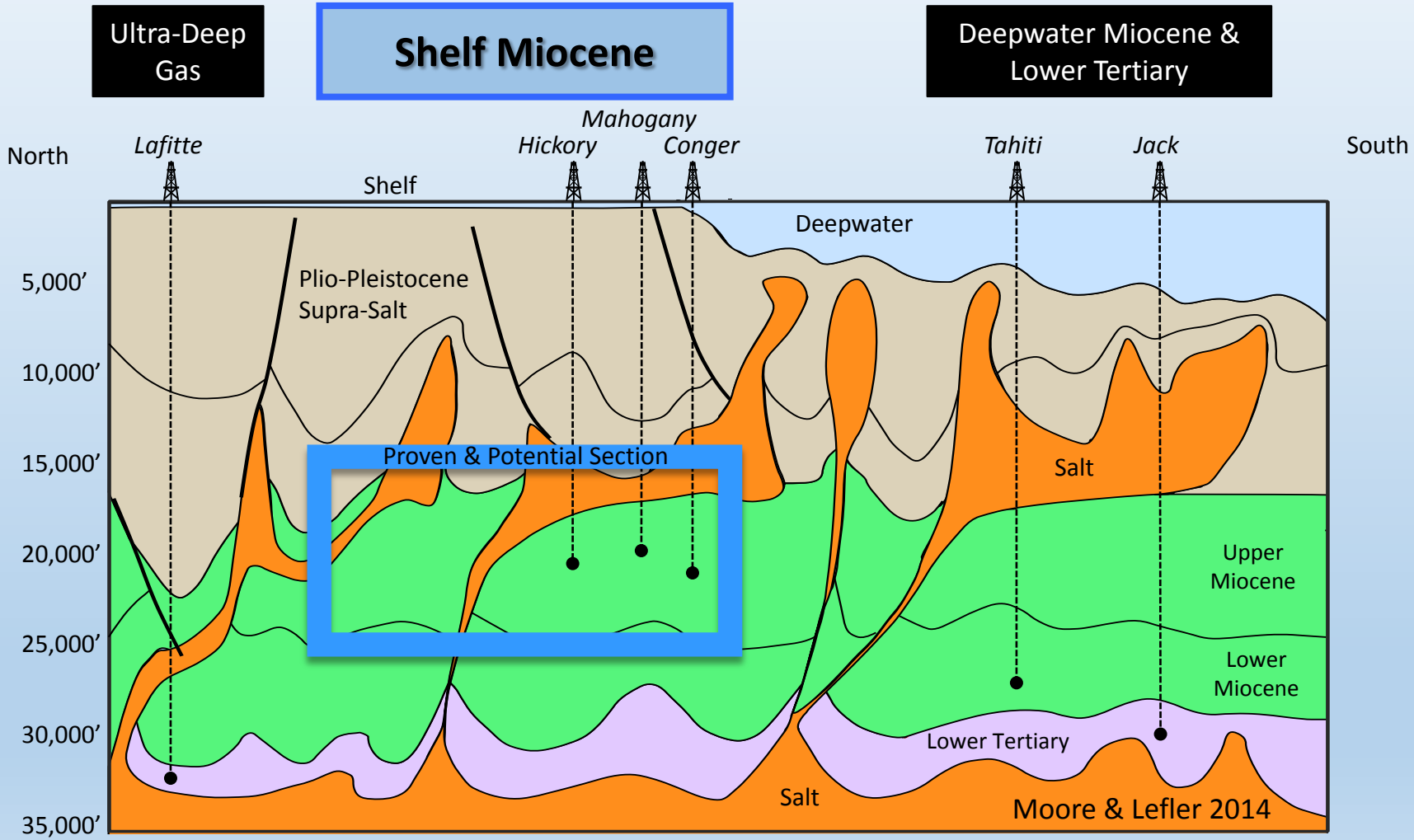
| Discovered | 1St Prod |
|---|---|
| 1998 | 1999 |

**Tarantula >15 MMBoe**

| Discovered | 1St Prod |
|---|---|
| 2001 | 2004 |



# Shelf Miocene Sub-Salt Target Section



# Evolution of the Shelf Miocene Sub-Salt Play

***The play was 1st produced in the 1990's but older technology left potential giant fields behind***

### *Thick sand below salt discovered by accident*

- SMI 200 well discovered 1000' of thick reservoir sand below an unexpected salt sheet, in late 1985

### *Shift to Deepwater*

- Seismic advances led to massive discoveries in deepwater GoM, followed globally (Brazil, West Africa, East Africa, and others)
- Extensive R&D spending on sub-salt imaging & drilling due to global "size of the prize"

### *GulfSlope Captures Leading Lease Position*

- Industry applies RTM to Shelf Miocene Sub-Salt play
- **GulfSlope acquires a leading position in the Shelf Miocene Sub-Salt play**

- 1990 - Shelf Miocene Sub-Salt Play 1st Developed

- 2000 - Sub-Salt Seismic Successful in deepwater

- 2010 - Deepwater Technology Re-applies to the Shelf

### *Mahogany discovered in 1993, with 400+ MMboe discovered in play by 2000*

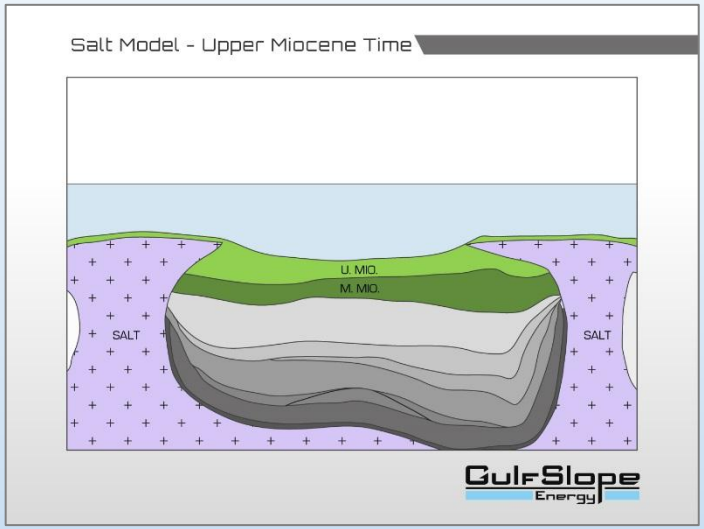
### *Shelf Miocene Sub-Salt Exploration Limited by Seismic Clarity*

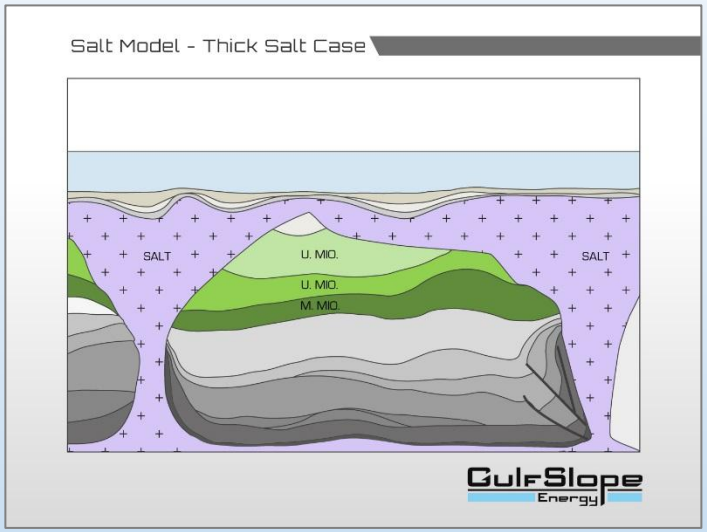
- Early sub-salt seismic had difficulty with GoM shelf
- Play limited by drilling depth capabilities

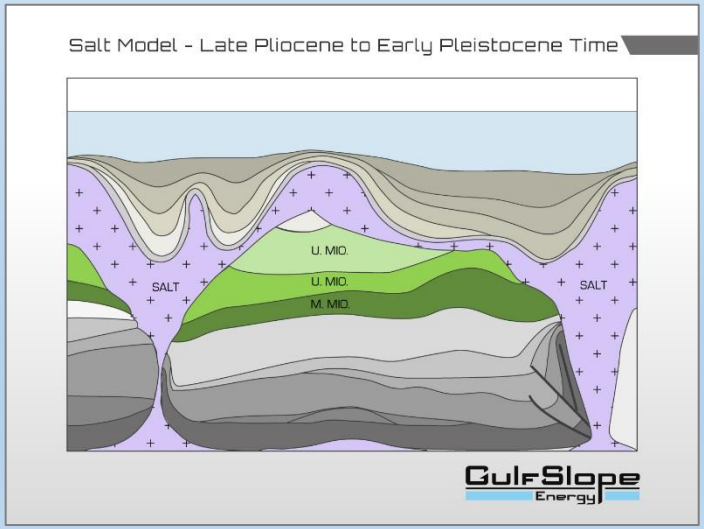
### *Seismic Advancements*

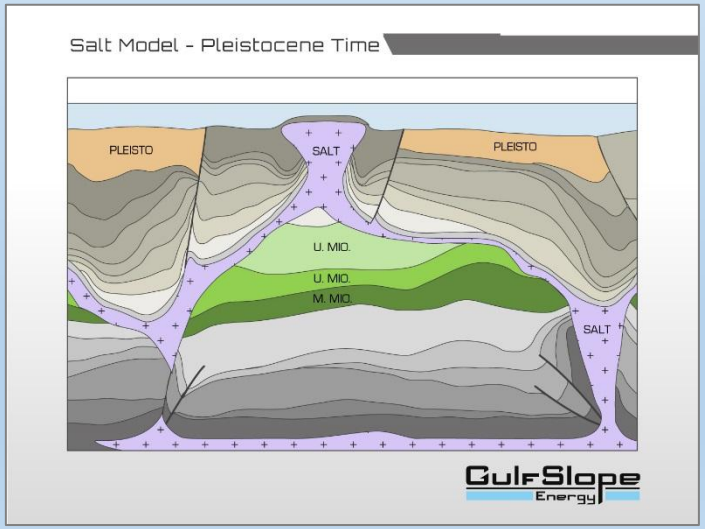
- New Reverse Time Migration (RTM) more accurately images sub-salt
- RTM and other technologies proven successful in sub-salt deepwater GoM, Brazil, West Africa, & East Africa

# Dynamic Salt & Sediment Model



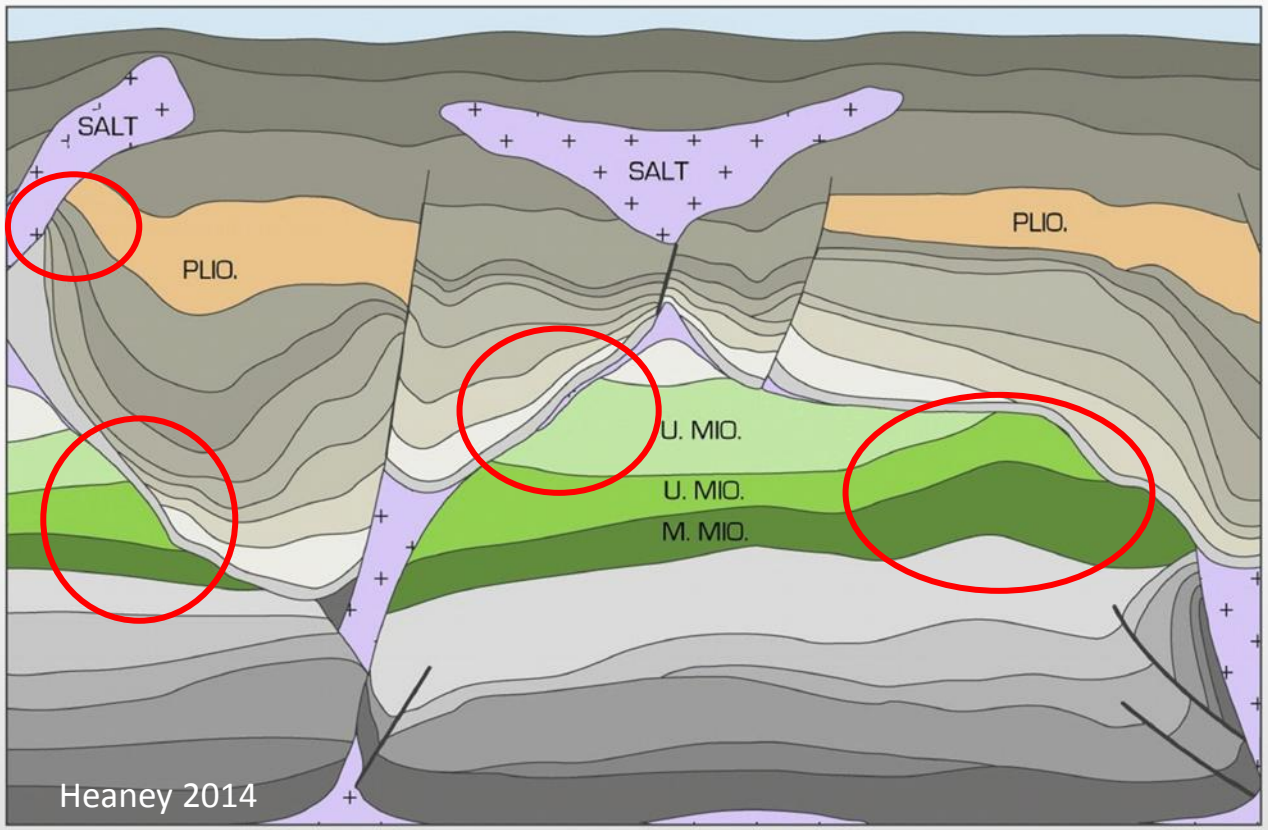




Heaney 2014

# Observed Trap Styles in Play Area Today

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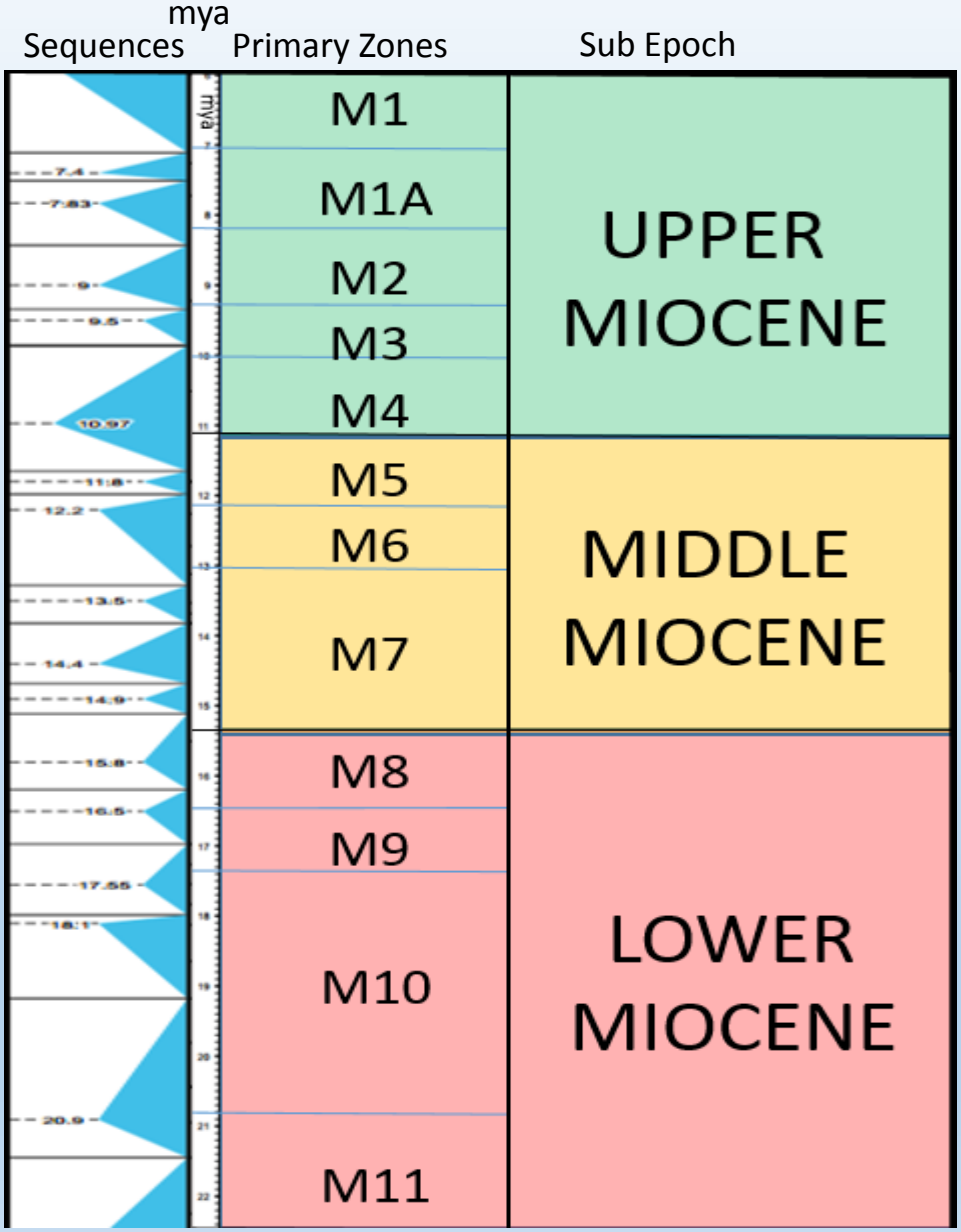
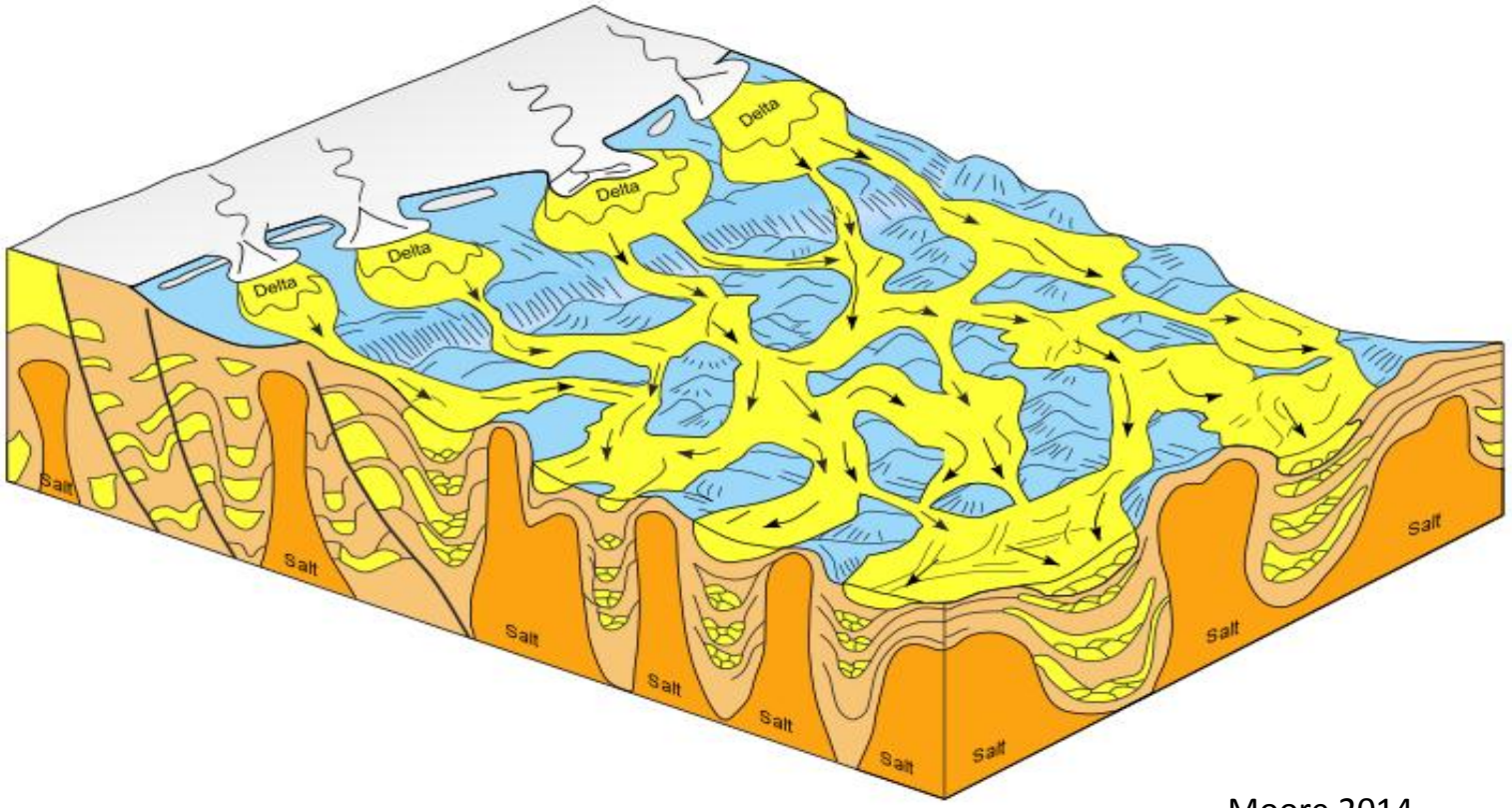
# 15+ Sequences - Lowstand Sand Potential

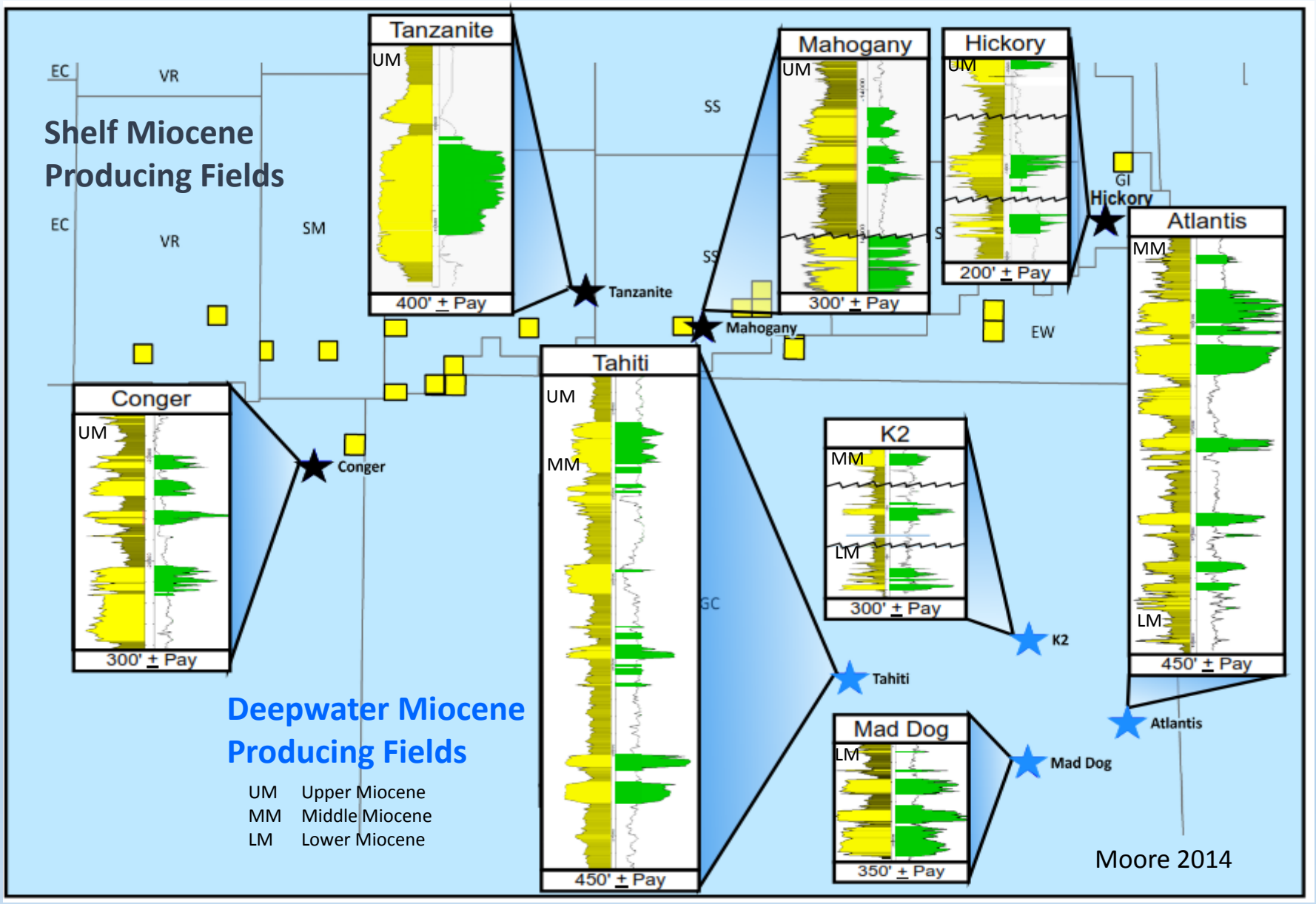


# Miocene Deltas Fed Salt-Supported Extended-Slope, Creating Confined Mini-Basins

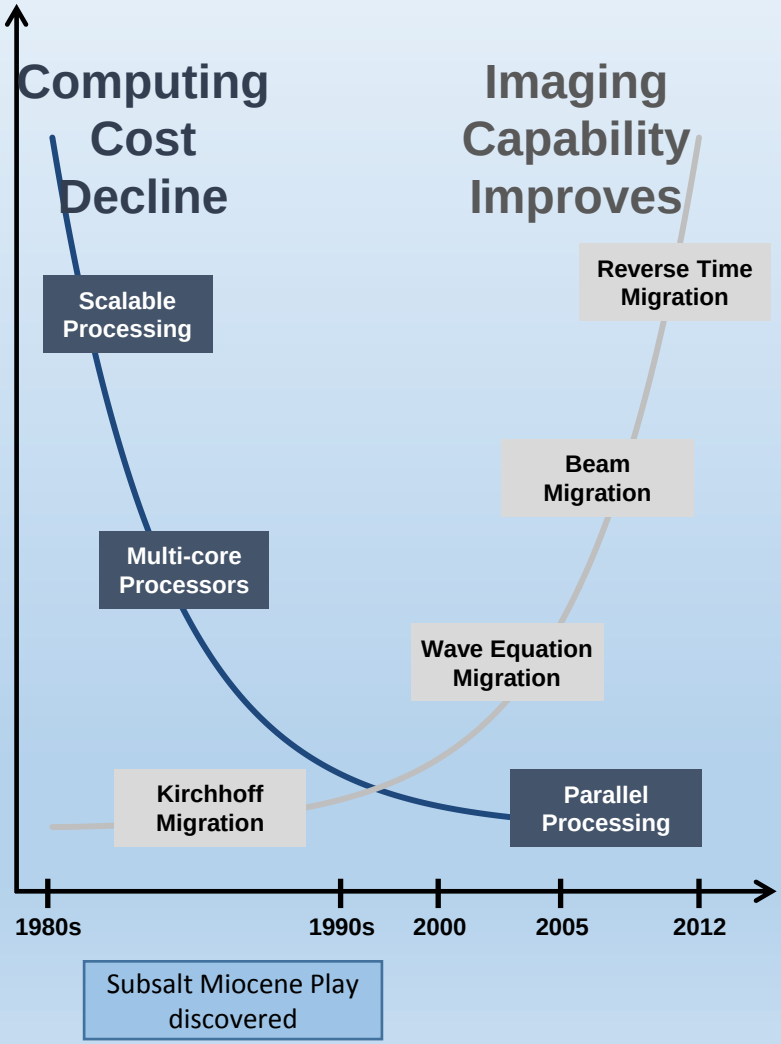



Moore 2014

# Miocene Subsalt Pay Sands - Slope Fans + Basin Floor Fans



# Advanced Seismic Technology
# Better Imaging at Lower Cost

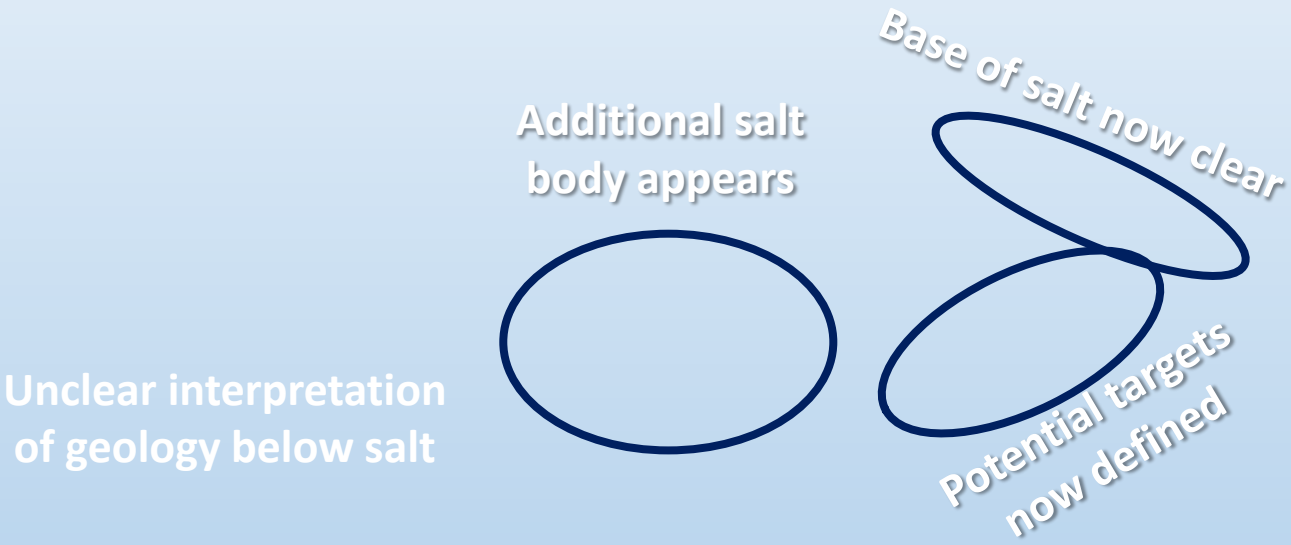



- Technology Evolution
  - Seismic Processing
    - Faster, better and cheaper processing techniques
    - Advanced processing yields the most accurate view of subsalt prospects
  - Algorithm Evolution
    - 1990s: Kirchhoff
    - 2000s: WEM and Beam migration
    - Today: RTM

# Seismic Processing Improvements

***Why this Opportunity Still Exists Today…***

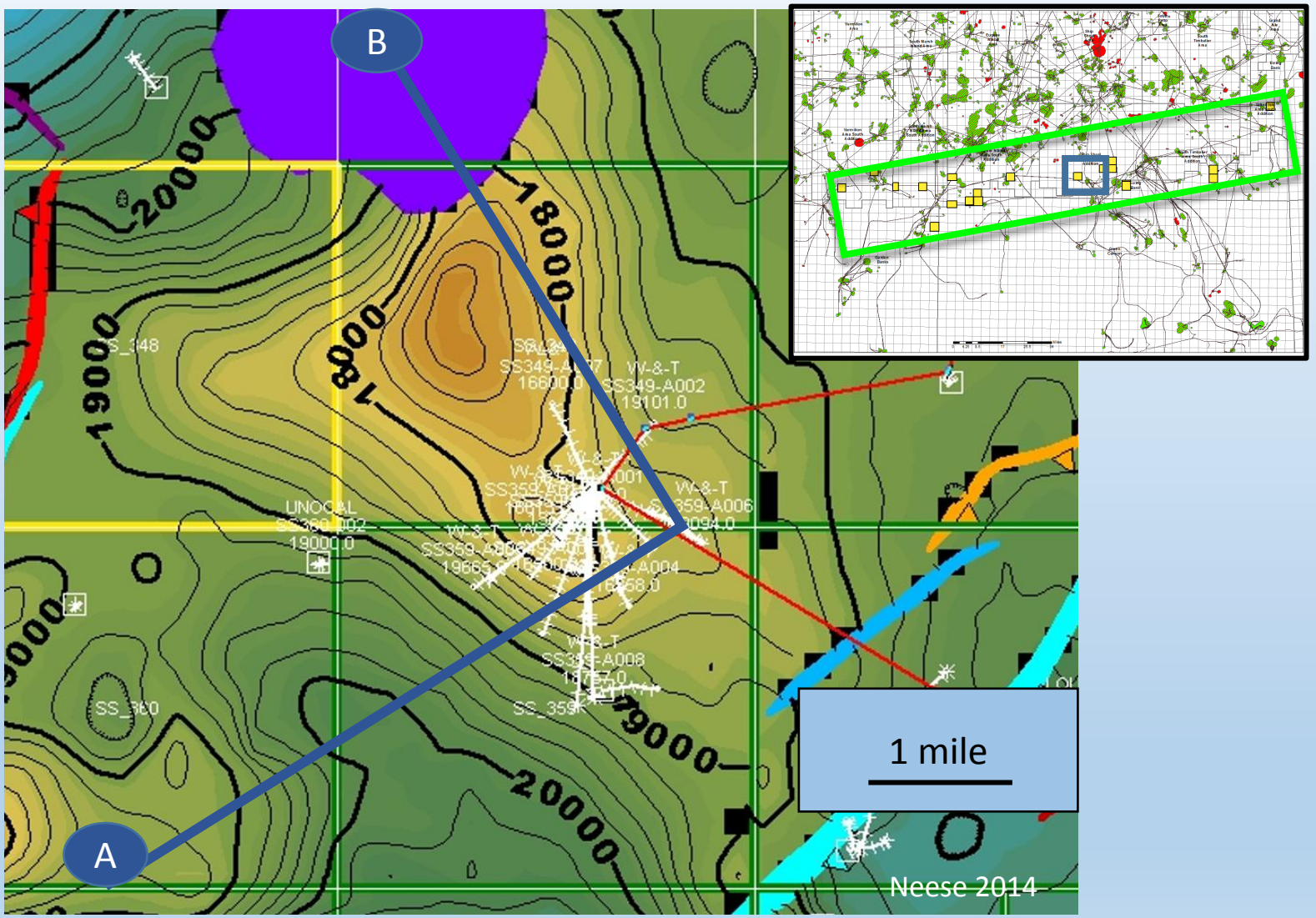
| Legacy: WEM Processing | Modern: RTM Reprocessed |
|---|---|




Previous generations of seismic sub-salt images were often unclear

Recent advances in seismic processing provide clearer images

# Mahogany Simplified Structure Map



# Geophysical Advantage of Play

**Advanced Seismic Technology**
**now allows us to find**
**Deepwater Size Prospects in Shallow Water**

# Geologic Advantages of Play

- High Porosity-Permeability Miocene Sand Reservoirs
- Slope Fans  & Amalgamated Channels - Confined Mini-Basin Geometries
- 5 Key Fields – Conger, Mahogany, Hickory, Tanzanite, Enchilada
- Proven Petroleum System – High Volumes Liquid Oil and/or Condensate
- New & Advanced Seismic Processing Clarifies Sub-Salt Imaging

# Economic Advantages of Play

- Moderate Drill Depths – 15,000’ – 25,000’ – Good pressure drives
- Mostly Jack-up Rig Access - $ 125-175K/day - $ 40-60 MM per wildcat
- Mostly Conventional Platforms - $40-75 MM per platform
- Existing Platform-Pipeline Infrastructure across area

# Emerging Shelf Play = Shelf Miocene Sub-Salt Play

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