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180342-MS
Mitigating Salt and Sub-salt Drilling Challenges Using Hybrid Bit Technology in Deepwater, Gulf of Mexico

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Outline

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- Challenges
  - Drilling through salt
  - Drilling dynamics with PDC bits
  - Bit reamer synchronization
  - Offset drilling performance
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- Results
  - Salt
  - Sub-salt
- Conclusion
- Acknowledgement & Questions

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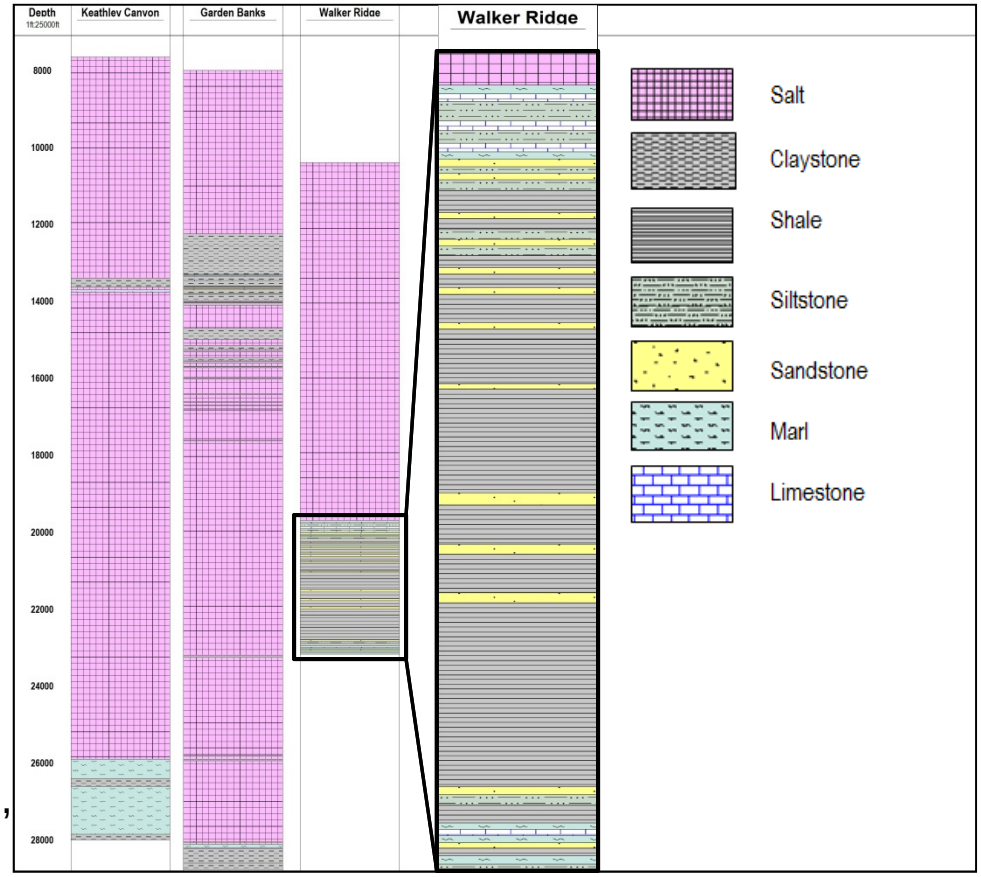
Introduction

- Location
  - Walker Ridge
  - Keathley Canyon
  - Garden Banks
- Water Depth
  - > 4,000ft
- Well Profile & Target
  - Vertical & “J” Profile
  - DLS < 1.5° / 100ft
- Lithology
  - Salt: Mostly Halite-Some Sylvite
  - Sub-salt: Shale, Sandstone, Marl, Siltstone & Limestone Stringers



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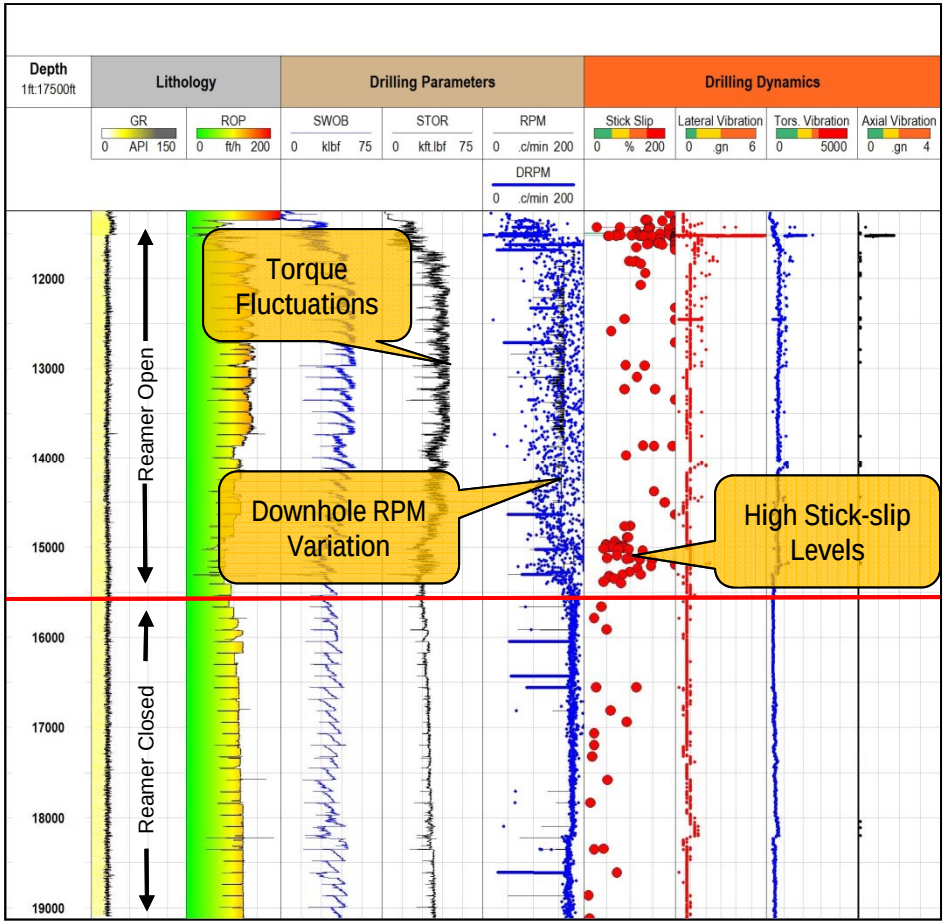
Drilling Challenges

- Drilling Through Salt
  - Creep
  - Rubble zone
- Drilling Dynamics
  - Torque fluctuation
  - Stick-slip & lateral vibration
- Bit and Reamer Synchronization
- Offset Drilling Performance
- Directional Control with RSS BHA



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Drivers for Engineered Bit Solution

- Enhance the drilling performance in salt and sub-salt formations.
- Mitigate torque fluctuation while drilling through salt and interbedded sub-salt formations.
- Increase drilling efficiency.
- Enhance bit / BHA reliability and run length.
- Provide good directional control with the rotary steerable tool.

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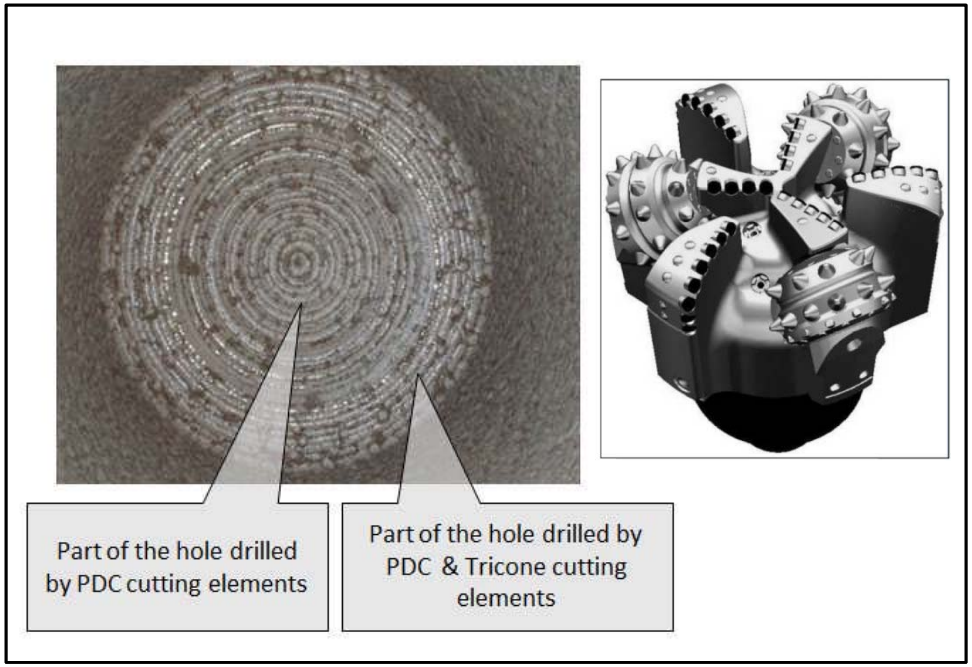
Hybrid Bit

- Dual Cutting Mechanics
  - Crushing & Gouging
  - Shearing
- Roller-cone Elements
  - Pre-stresses the rock
  - Provides depth of cut control
  - Mitigates torque fluctuation
- PDC Cutting Elements
  - Aggressiveness
- Hydraulics
  - Jets closer to hole bottom
- Catastrophic Loss
  - Addressed by design



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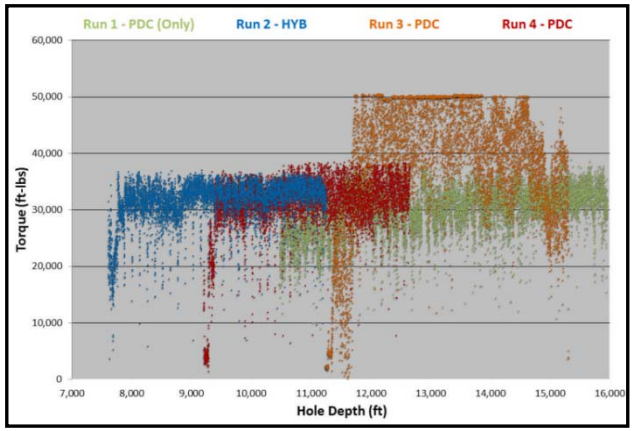
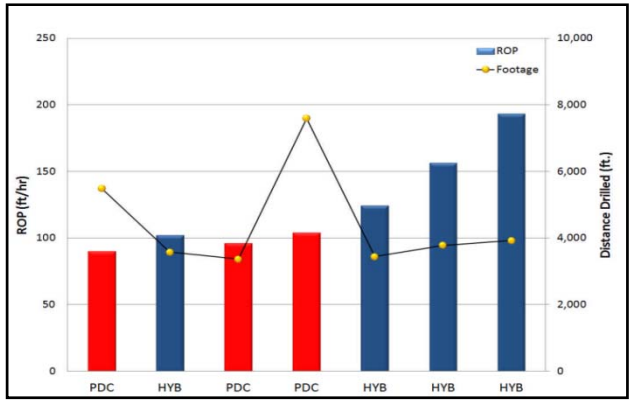
Results - Salt



Run No.	Torque (ft-lb)	
	Mean	Standard Dev.
Run 1- PDC	29,788.6	3,989.5
Run 2 - HYB	31,453.3	3,843.9
Run 3 - PDC	38,260.9	10,915.0
Run 4 - PDC	30,952.8	5,484.8

- Torque
  - Torque generated with hybrid bit was lower when compared to PDC bit bits.



- Penetration Rate
  - First hybrid run achieved 102.0 ft/hr with conservative parameters.
  - Subsequent runs achieved 124.5, 156.6, 193.4 ft/hr.

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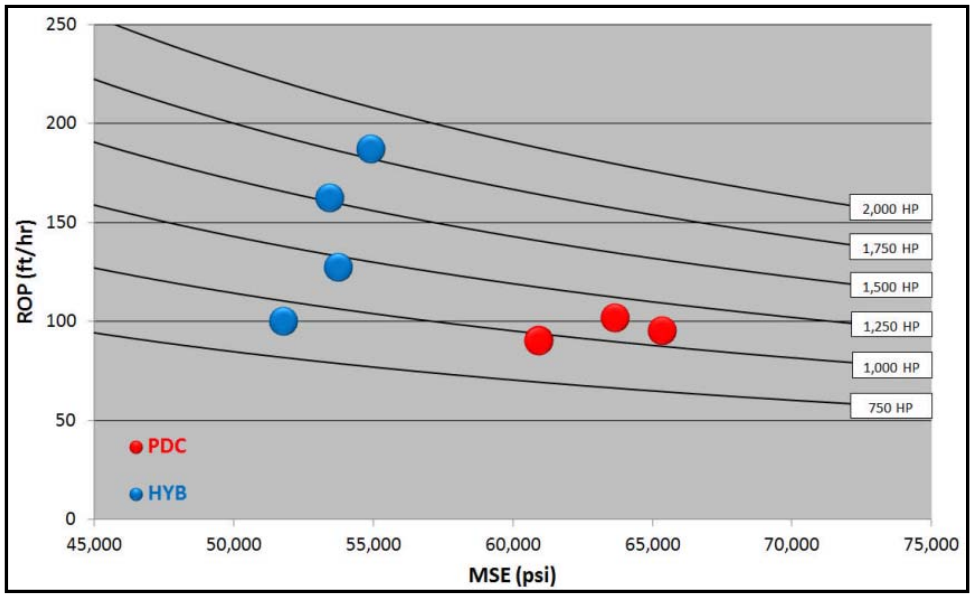
Results - Salt

- Drilling Efficiency
  - Comparison of mechanical specific energy (MSE) for each bit run Hybrid bit shows higher drilling efficiency compared to PDC runs.
  - For a given MSE input, lower value more mechanically efficient drillings.



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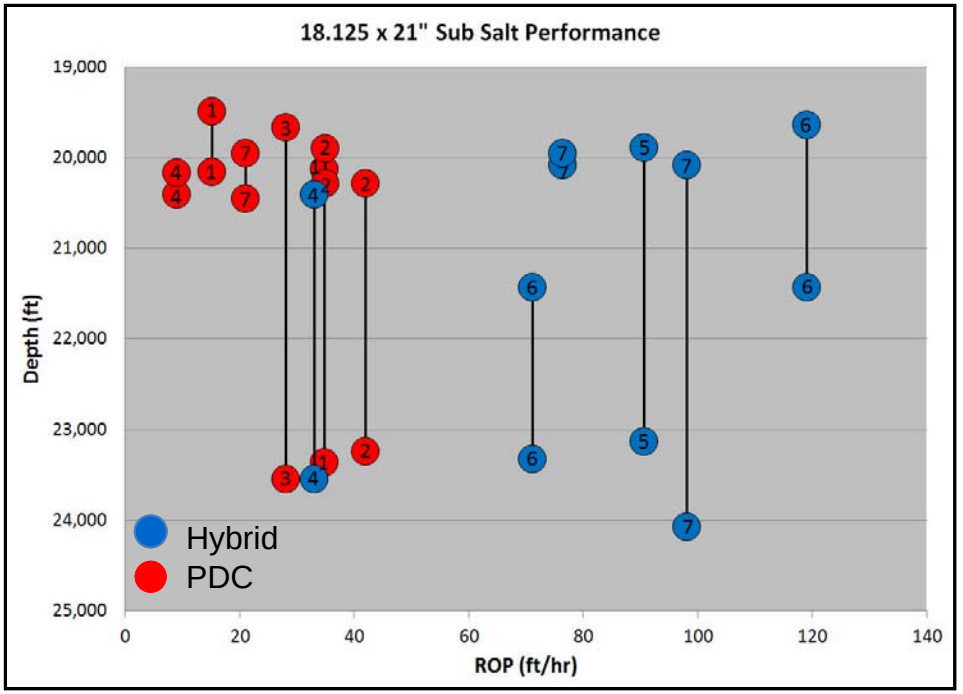
Results – Sub-salt

- Seven wells were studied
- Average ROP were reviewed
- Hybrid runs displayed better ROP
- Hybrid bits completed the section
  - Well #6 pulled for top drive issues
  - Well #7 pulled to pickup RSS



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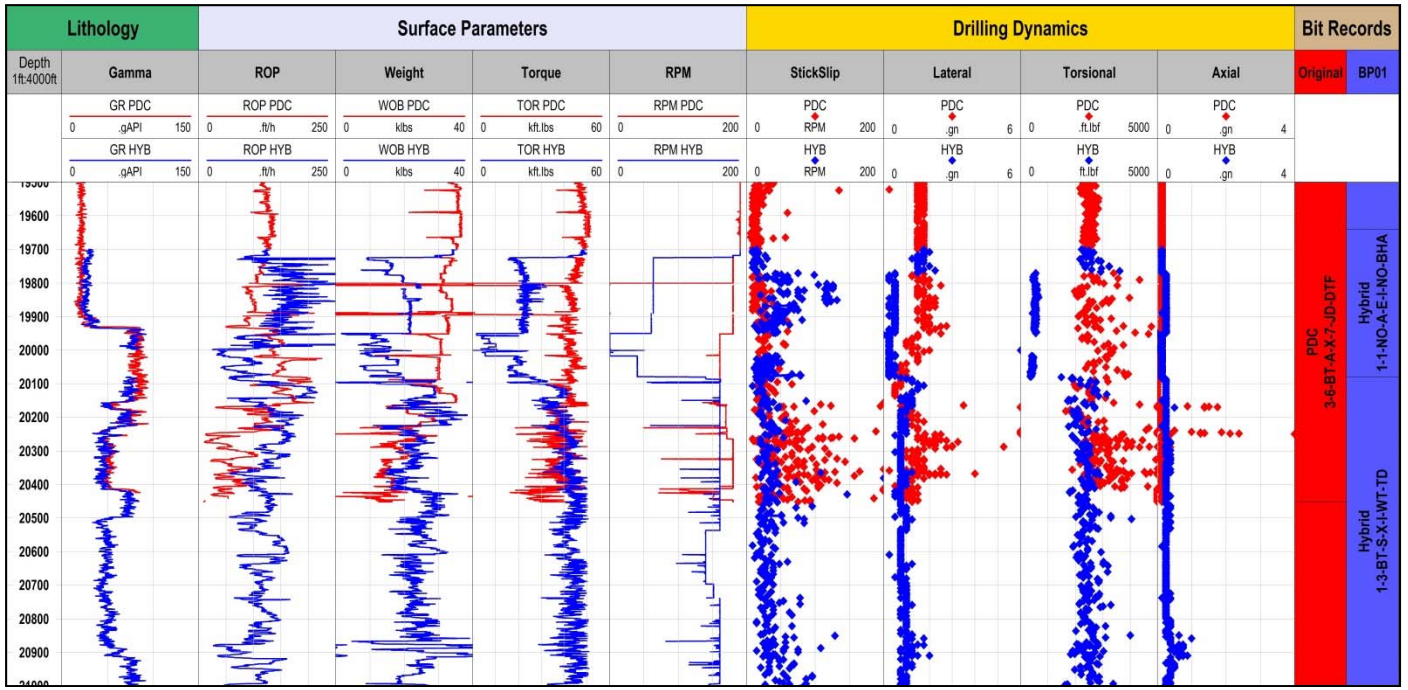
Results – Sub-salt

- Drilling Dynamics

- Hybrid bits displayed lower vibration levels while drilling Pliocene sandstone.

- Hybrid bit drilled the similar formation with lower vibration.



Hybrid
PDC

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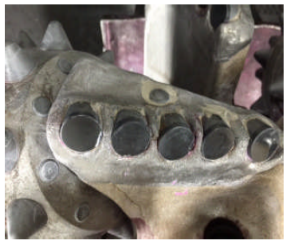
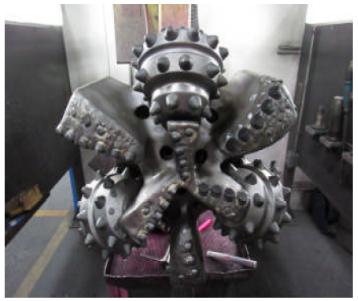
Results – Sub-salt

- Drilling Dynamics

- Significant abrasive wear on PDC bits.

- Impact damage was also noted.

- Hybrid bit cutting structures were preserved.

PDC Dull Pictures		Hybrid Dull Pictures	
			
			

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Conclusion

- Hybrid bits can drill salt and sub-salt formation at faster penetration rates compared to PDC bits.
- Drilling efficiency of the hybrid drill bits are significantly higher compared to PDC bits in salt.
- Compared to a PDC bits, hybrid bits display better stability in salt and sub-salt formations.
- Hybrid bits display lower torque fluctuation compared to PDC bits.
- The hybrid bits proved to be more durable in the hard clastic formations of the sub-salt interval.

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