ePS The Deep Water Drilling Tolerance Window: Walking a Fine Line, Case Histories from Gulf of Mexico*

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Abstract

Exploring for hydrocarbon in deep water has considerably changed the oil and gas industry premise. Great prospects have been abandoned due to their drilling complexity. The substantially increased water depth has impacted the subsurface geopressure profile and consequently all aspects of exploration especially drilling.

The behavior of the subsurface geopressure profile is driven by subsea water depth and stresses created by sedimentation rate, lithology, and structural setting. Stress reduction due to subsea water depth is the main reasons of narrowing the safe drilling envelop between the pore and fracture pressures i.e. Drilling Tolerance Window (DTW). This leads to limited maneuverability to control and overcome the formation pressure using mud weight.

In the deep water there are four subsurface pressure zones. They are from the top to the bottom: (1) the shallow free flow, (2) hydrodynamic, (3) transition, and (4) geopressured. Each zone has its own pressure gradient dictated by stress and compartmentalization.

The most common drilling challenges in the upper two zones are limited to Loss of Circulation (LOC) and Shallow Water Flow (SWF). On the other hand, in the transition and lower geopressured zones, higher pressure has recently emerged as a new challenge, during testing deep prospects. Hard kicks, high torques, mud cuts, flow-kill-LOC phenomenon and even uncontrollable blow out can take place in these deep geopressured zones.
In this study, several case histories from Mississippi Canyon, Walker Ridge and East Breaks areas exhibit the drilling challenges due to narrow DTW. The examined wells show that excess pressure created by compartmentalization between the shale and sand is usually

amplified by the presence of hydrocarbon. Drilling the interface between seal and pay sand in the geopressured zone is the most troublesome drilling zone e.g. Deep Horizon in MC 225.

To safely walk this fine line, several steps need to be taken. Before drilling, a calibrated geopressure model needs to be diligently assessed from seismic velocities and offset wells. During drilling, model parameters and mud weight should be adjusted frequently, especially across the shale - sand interface and potential pay zones. The Blowout Preventer (BOP) is the last line of defense to control the hard kick of an unexpected pressure surge.

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The Deep Water Drilling Tolerance Window :

Walking a Fine Line , Case Histories from GoM

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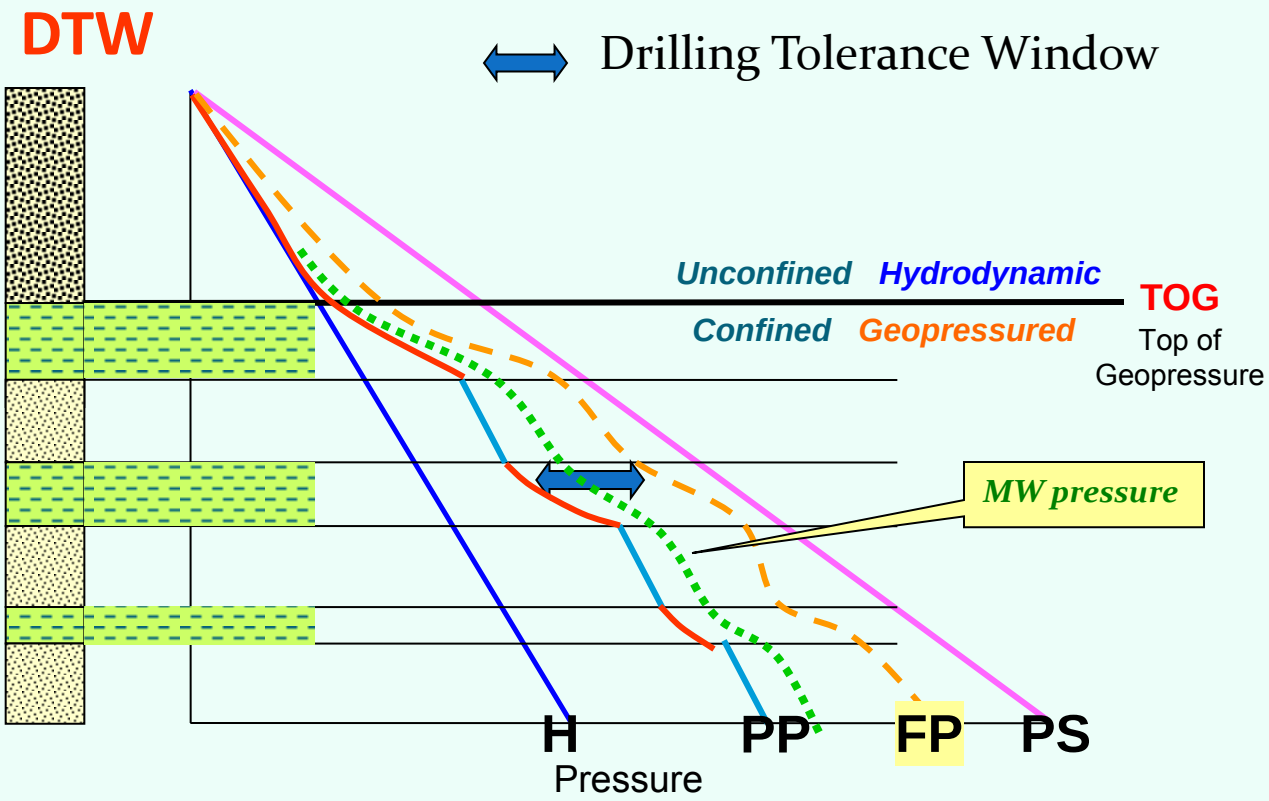

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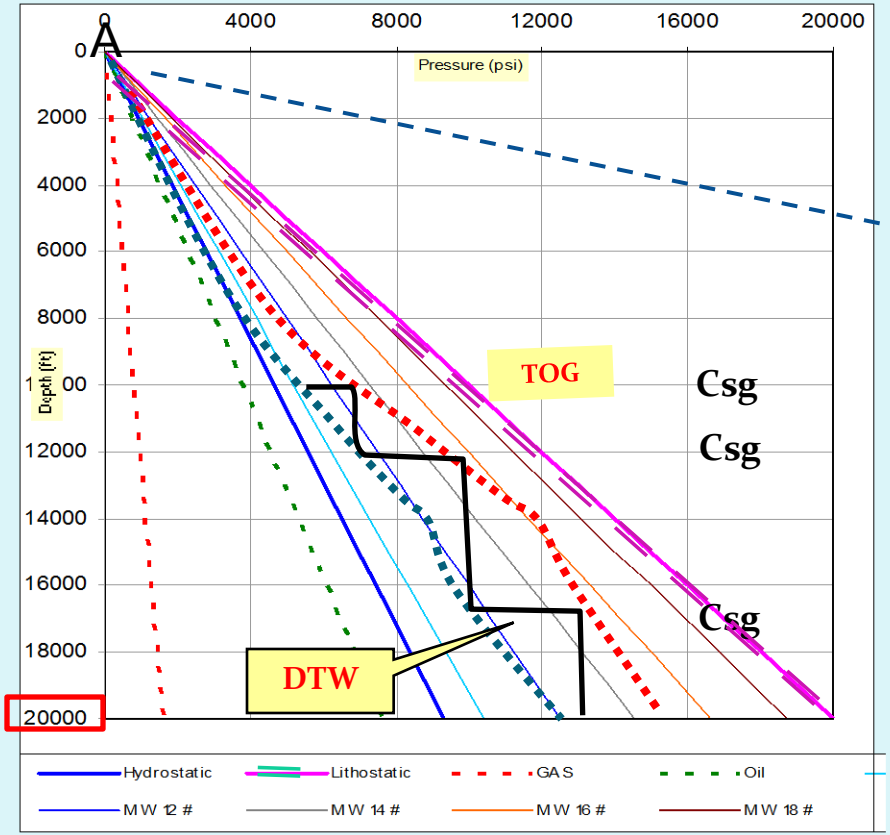
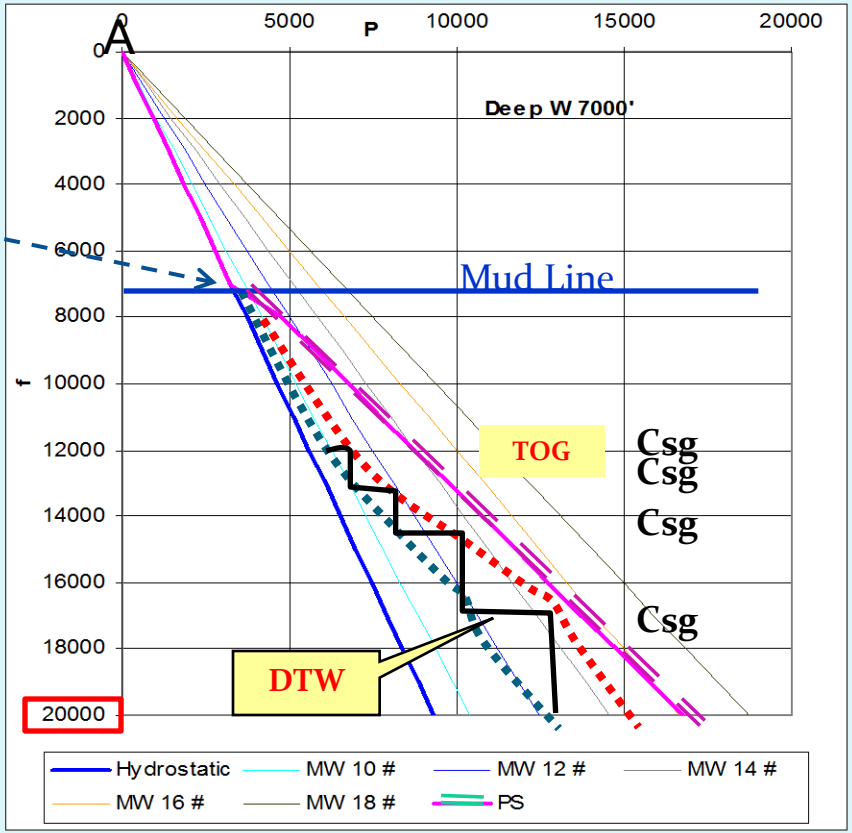
Shallow vs. Deep Water PP profiles:





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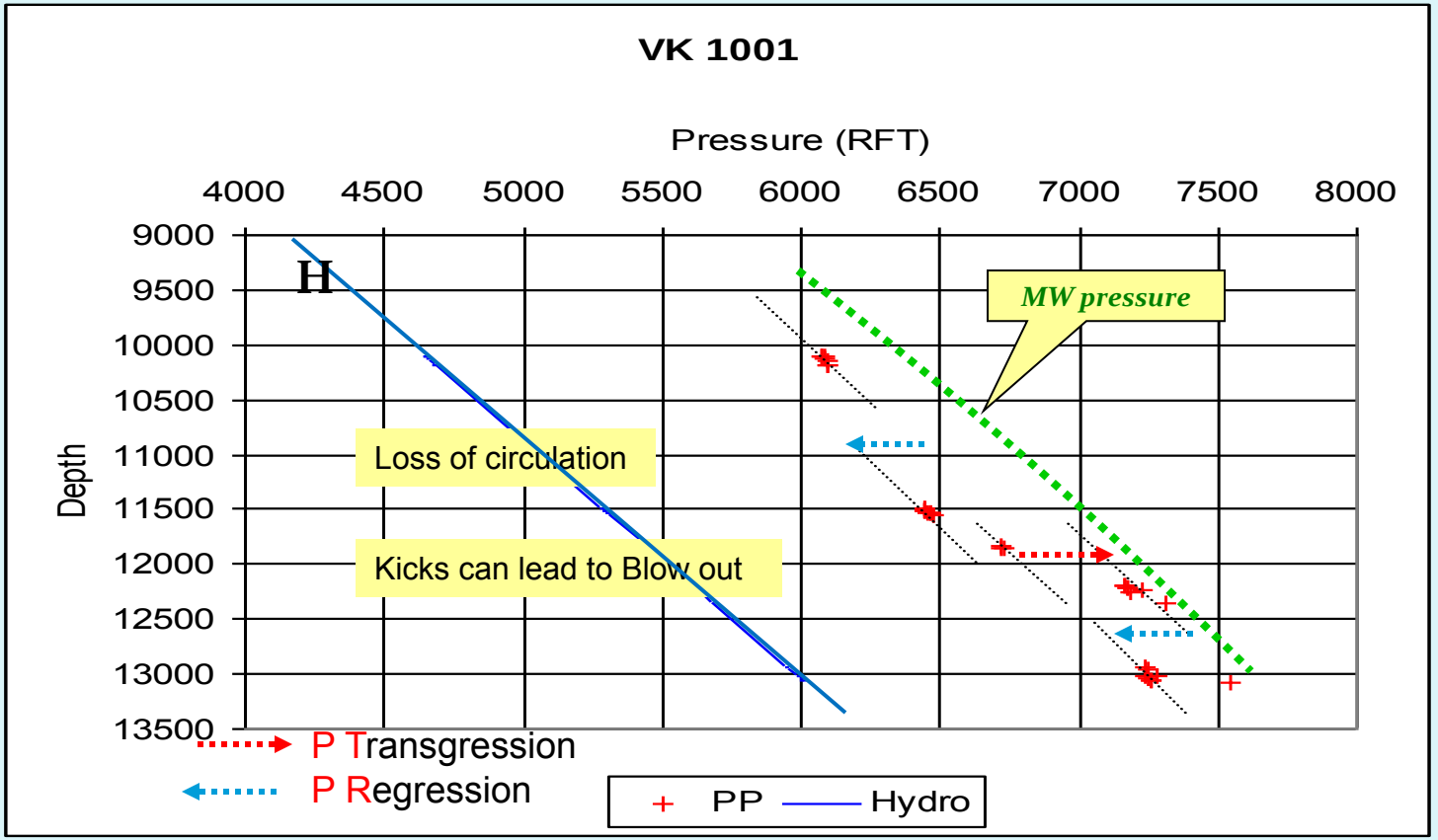
Challenges due to Transgression and Regression



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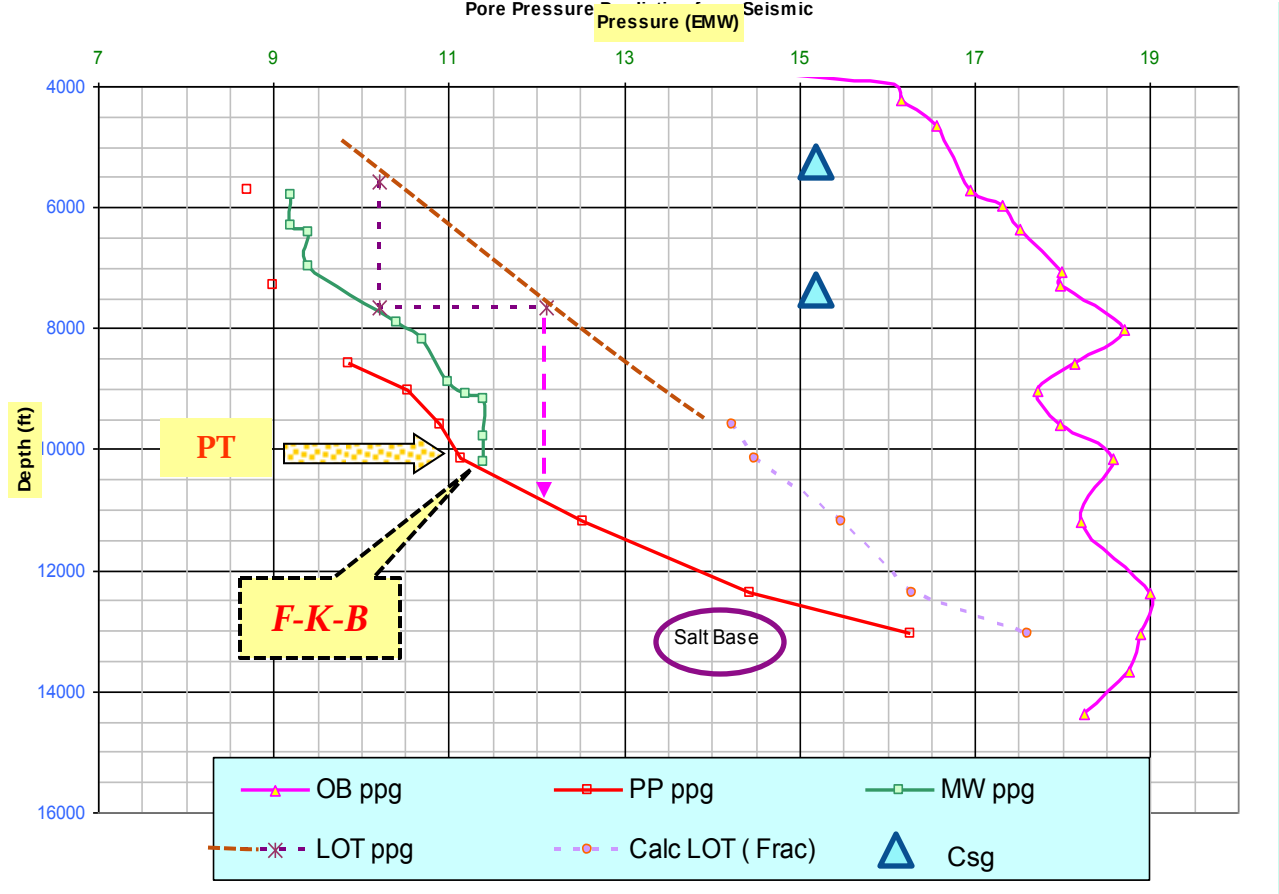
Well abandonment in East Break due to the proximity of Mud and Formation Pressures



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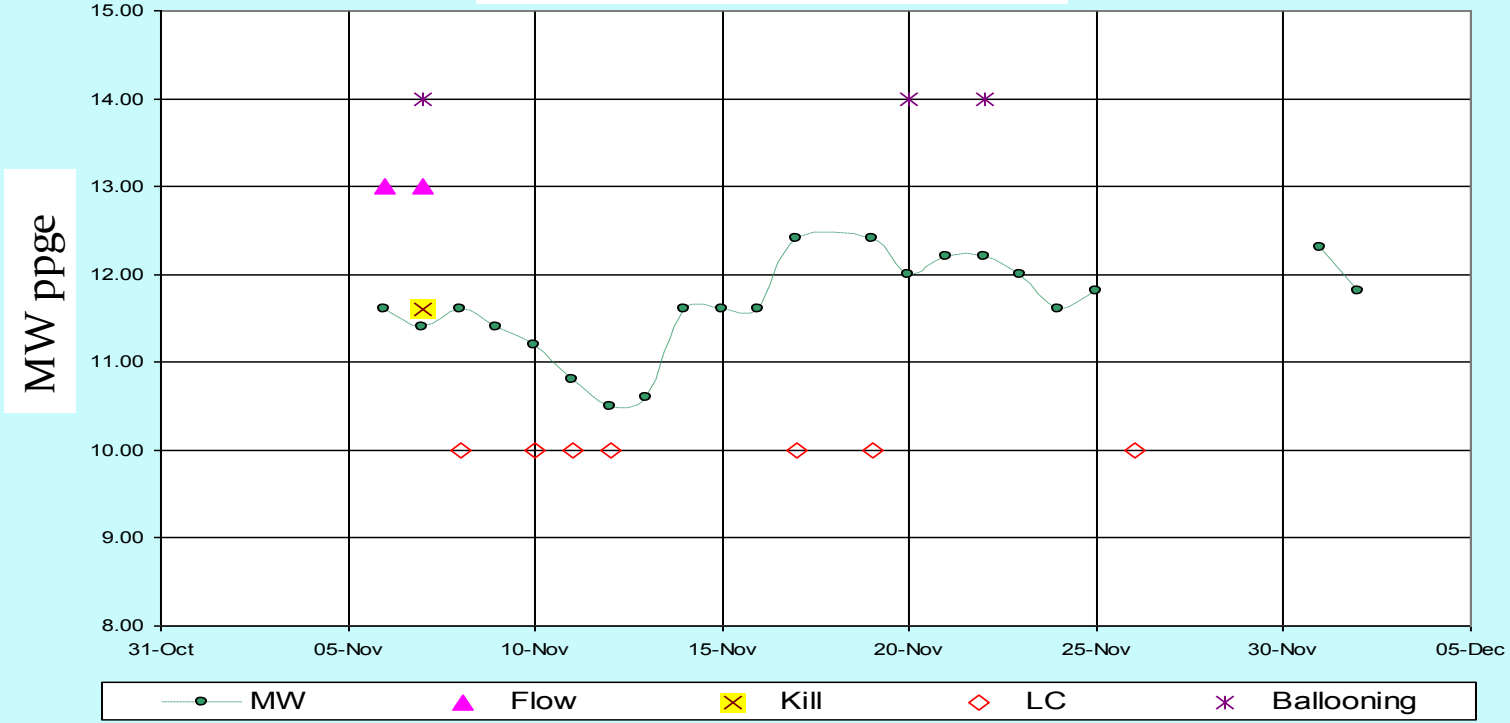
Flow – Kill – Breakdown (LOC)
FKB Cycle



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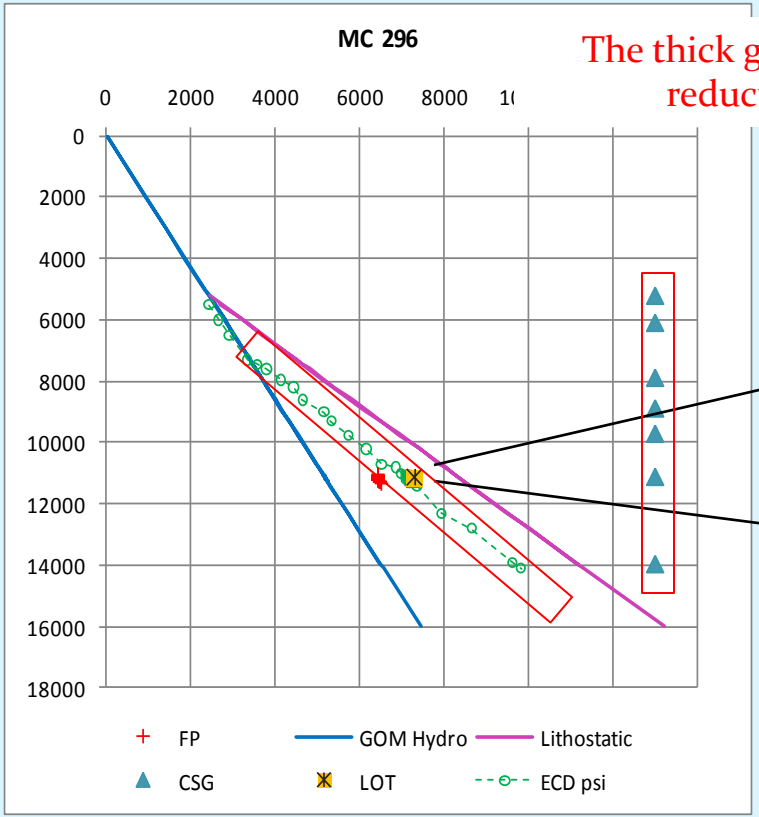
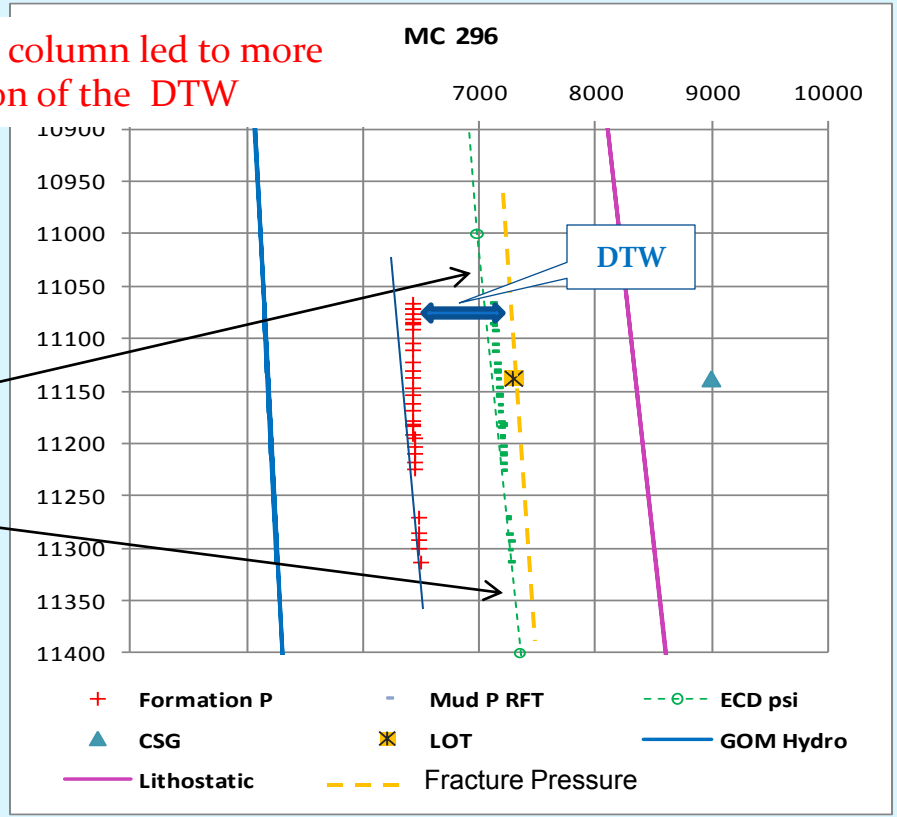
The Impact of hydrocarbon on the narrow DTW in Mississippi Canyon 296



The thick gas column led to more reduction of the DTW



Immediate south of DW Horizon block MC 252

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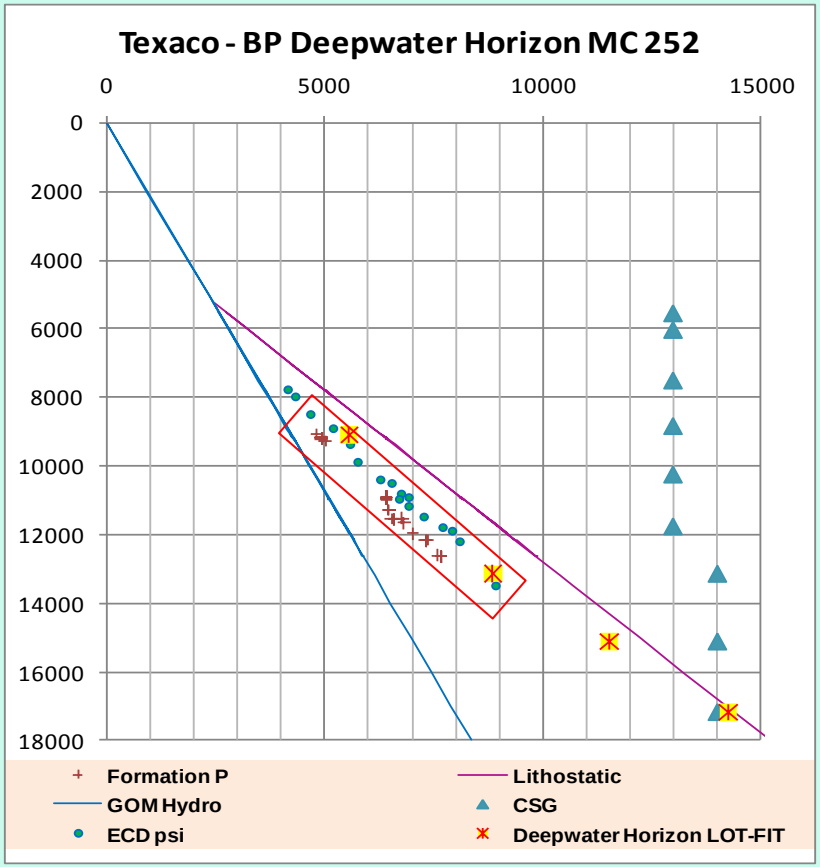
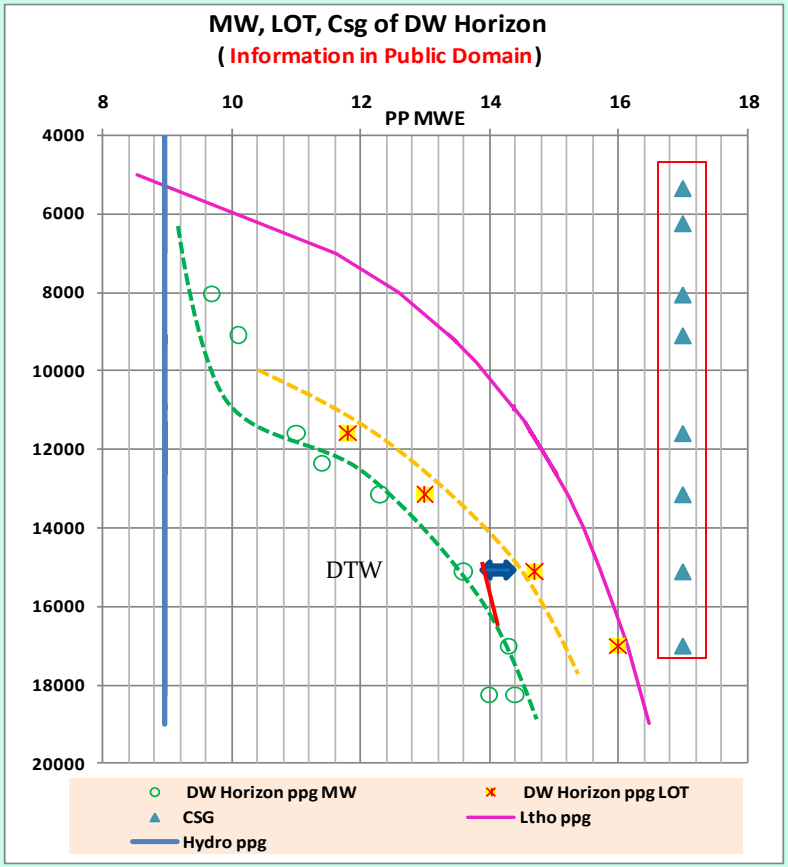
The Impact of the narrow DTW in Mississippi Canyon 252





The Narrow DTW in addition to the presence of hydrocarbon led to serious drilling challenges

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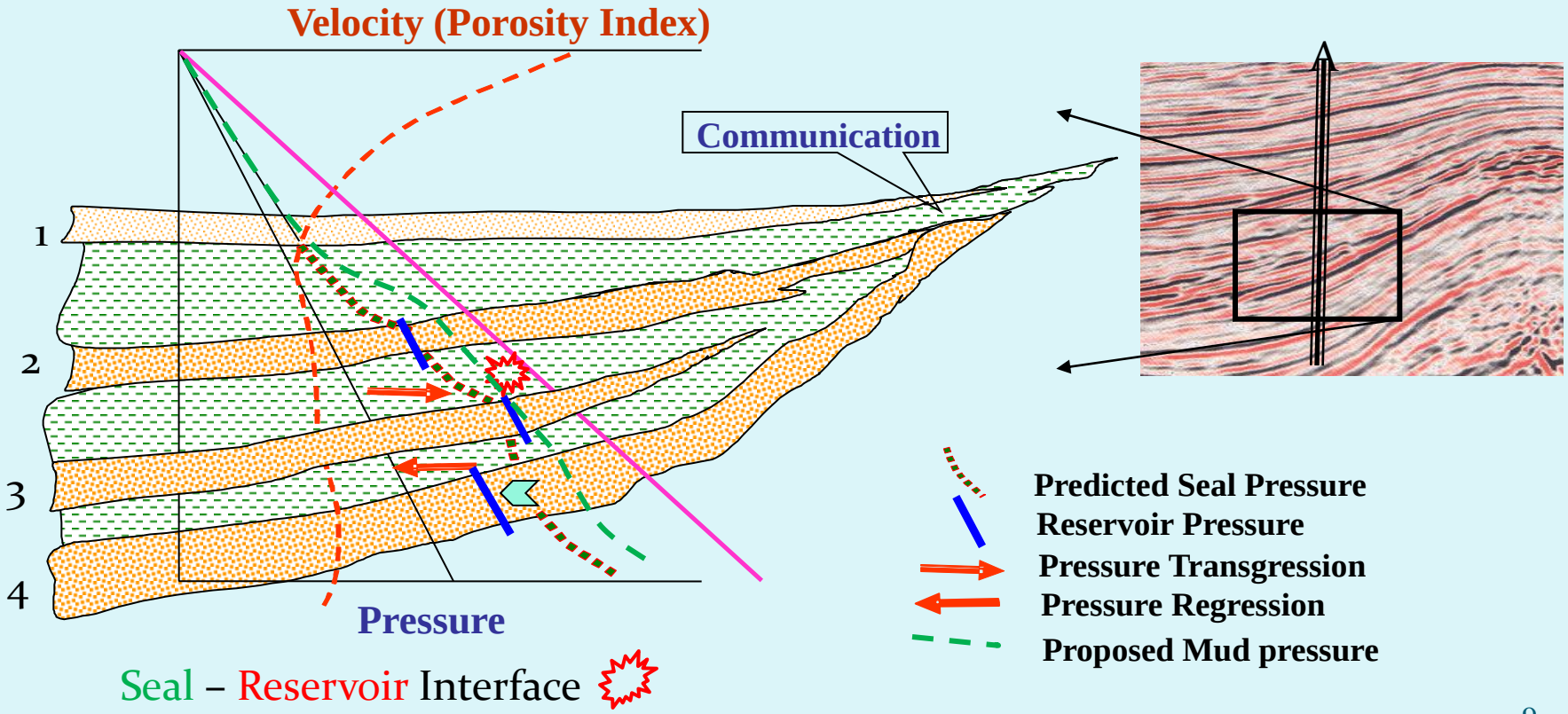
- *The importance of establishing the prospect 's geological building blocks for PP Predictions:*

Deposits geometry and facies changes



Conclusions

- The depth of sea floor (mud line) in Deepwater reduces the DTW

- Geopressure Transgression and Regression cause the disparity between seal and reservoir pressures especially in pay zones

- Bore hole instability, bypasses, side tracks , F-K-B cycle , possible blow-out, and failure to reach the prospective target are common in Deepwater due to the narrow DTW.

- Hydrocarbon presence reduces the safe DTW

- Establishing the geological building blocks for geopressure prediction goes hand in hand with prospect generation and forecasts drilling challenges.

- The most troublesome spots along the bore hole trajectory is the seal – reservoir interface.

Thank you