[PS]Prediction of Seal Failure and Reservoir Breaching in Deep Water*

Selim Simon Shaker[1]

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Abstract

A viable prospect with a good potential for hydrocarbon reserves requires four amalgamated components. Hydrocarbon source and the presence of reservoir that receives, contains and delivers the hydrocarbon to the wellhead. Top seal that is indispensable to keep the hydrocarbon trapped in the reservoir. Last, but not least, is the drillable feasibility of the prospect. The absence of any of the aforementioned criteria can lead to the abandonment of the whole prospect. However, the common known cause of reservoir breaching is seal failure. Some of the seal integrity symptom and prognosis can be foreseen during the prospect generation phase and ahead of spudding the well location. They can be categorized as follows:

Symptom:

- Subsurface structural failure such as faults
- Shallow faults that reach the mud line in deep water
- Intrusive salt-sediment interface
- Active diapiric Salt that impact the mud line topography
- Prospect closes against a salt weld
- Rocking basin

Diagnosis:

- The presence or lack of seismic velocity reversal vs. depth (top seal)
- High sand – shale ratio at the objective and lack of High Stand sequence
- Narrow drilling tolerance window (DTW) where the pore and fracture pressure are in proximity.
- The presence of large hydrocarbon column. It is a double-edged sword.

This article shows case histories where stratigraphy, structural setting, reservoir quality, hydrocarbon source, and seismic attributes support a viable prospect prior drilling. However, post drilling, these wells were deemed dry holes. A brief diagnostic assessment follows each case based on the above-mentioned causes of seal failure will be discussed. These issues need to be examined methodically during the process of generating a prospect. Geopressure coupled with sequence stratigraphy and basin modeling can help establish a winning endeavor.

Prediction of Seal Failure and Reservoir Breaching in Deep Water

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Geopressure Analysis Services

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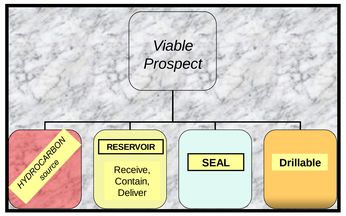
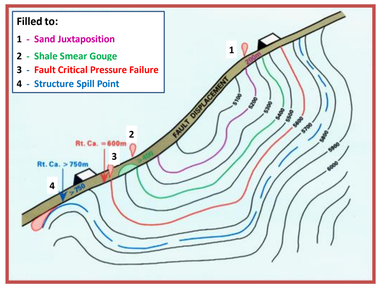


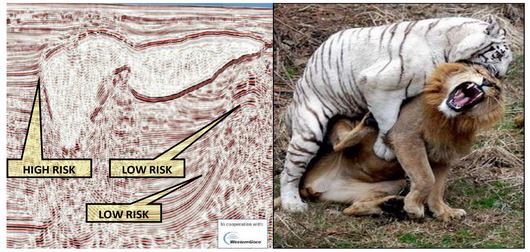
The four pillars of a potential successful prospect



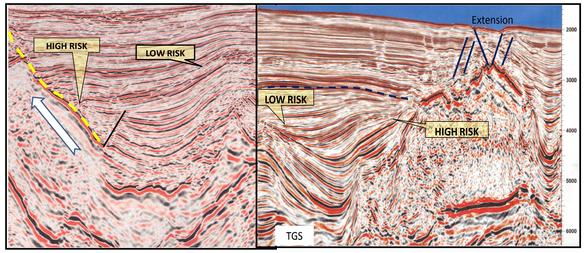
Options of reserves' estimate of a prospect or a discovery in a faulted three way closure.

SYMPTOMS

THE WONDERS OF SALT

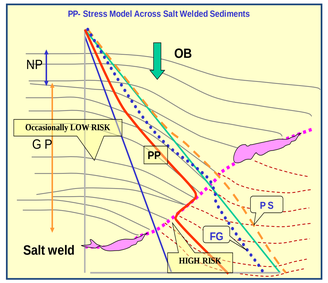


Deepwater Salt basins are widely explored for oil and gas in Gulf of Mexico , East S. America, West and North Africa. Salt agile mobility relative to the host sediment creates vast forms of exploration plays.

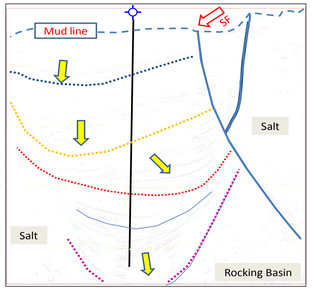


Salt's emplacement and displacement have great impact on seal integrity and prospect risk assessment.

Salt driven by sedimentation in Campos Basin, Brazil. Notice the low vs. high risk targets. High risk targets are associated with surface faults (SF) and thin overburden in a considerably deepwater.

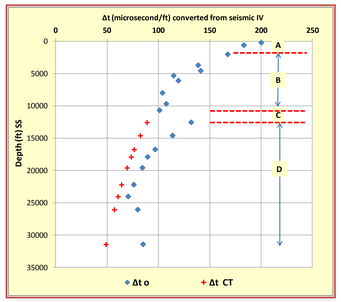


Salt weld is the result of salt mass withdrawal and the conjugation of different stratigraphic units . Pressure is usually depleted below the weld (seal failure) creating high risk traps.

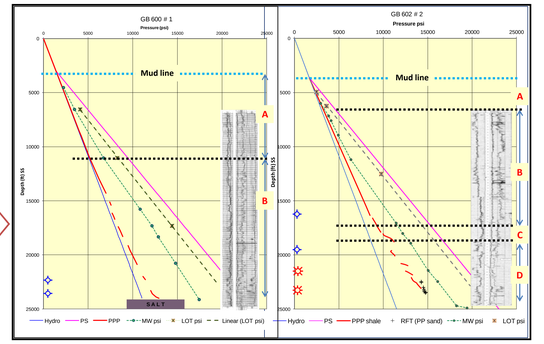


One of the rocking mini basins in the GOM. Notice the shift of the depositional axes (yellow arrows) during the Plio-Pleistocene time. The mud line topography is impacted by the shallow surface faults (SF) and shallow salt.

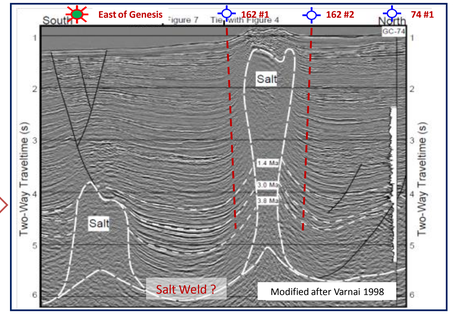
PROGNOSIS



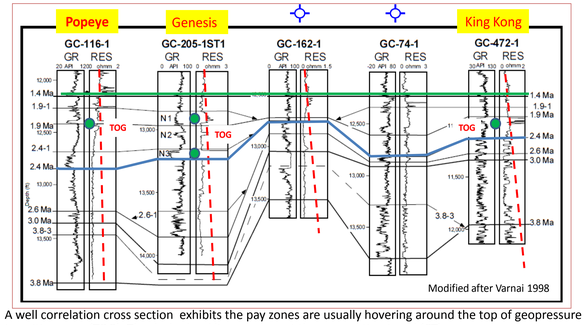
Before testing the prospect, a seismic velocity profile points to the good possibility of seal presence (C) where the exponential trend at zone B is reversed.



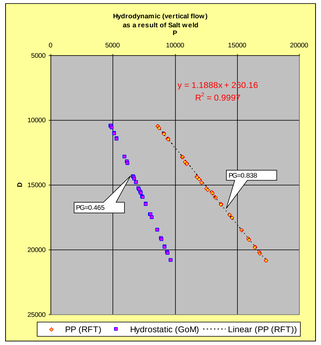
A correlation between a dry hole (left) and a producer (right) in the same mini-basin. The dry hole does not show reversal of the petrophysical measurements On the other hand, producer exhibits a seal at zone C where resistivity and velocity reverse the exponential trend.



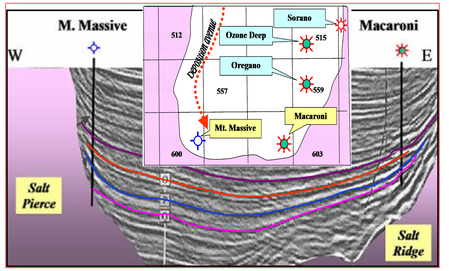
A seismic line shows sea floor mound on top of active salt diapir with two dry holes on each side in block GC 162. Prospect on GC 74 is closing against shallow fault and it might have a salt weld at the base. Genesis field sets on the top of deep seated salt dome with possible partially four way closure



A well correlation cross section exhibits the pay zones are usually hovering around the top of geopressure transition zone (TOG). The dashed red lines represent the compaction trend (CT).

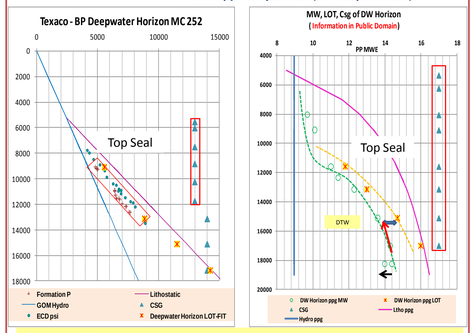


A pressure – depth plot of the Grand Canyon prospect (dry hole) closes against a salt weld. Notice the breached reservoir in a linear fashion upward flow



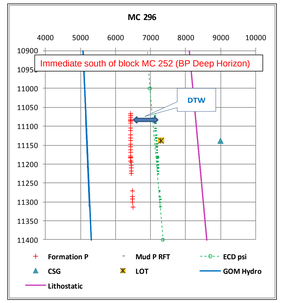
The different process of salt emplacement greatly impact the prospect risk. Note the dry hole sets on a salt pierce whereas, the discovery closes against a salt ridge. Moreover, the sediment at the west side of the basin was uplifted post sedimentation (Rocking Basin) due to salt emplacement. Therefore, the west side of this play concept deemed to be a high risk.

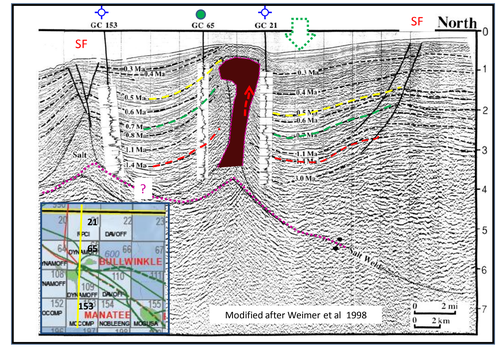
The narrow DTW on Mississippi Canyon 252 (BP Deep Horizon)



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

The thick hydrocarbon column led to a considerable reduction of the Drilling Tolerance Window (DTW)





A seismic cross section exhibits some of the possible geological features that make the difference between a discovery and dry hole.