Monday, April 14, 2008

Westchase Hilton • 9999 Westheimer
Social Hour 5:30–6:30 p.m.
Dinner 6:30–7:30 p.m.

Cost: $30 Preregistered members; $35 non-members & walk-ups

The HGS prefers that you make your reservations on-line through the HGS website at www.hgs.org. If you have no Internet access, you can e-mail reservations@hgs.org, or call the office at 713-463-9476 (include your name, e-mail address, meeting you are attending, phone number and membership ID#).

The Double Edged Sword: The Impact of the Interaction between Salt and Sediment on Sub-salt Exploration Risk in Deepwater from Mahogany to Jack

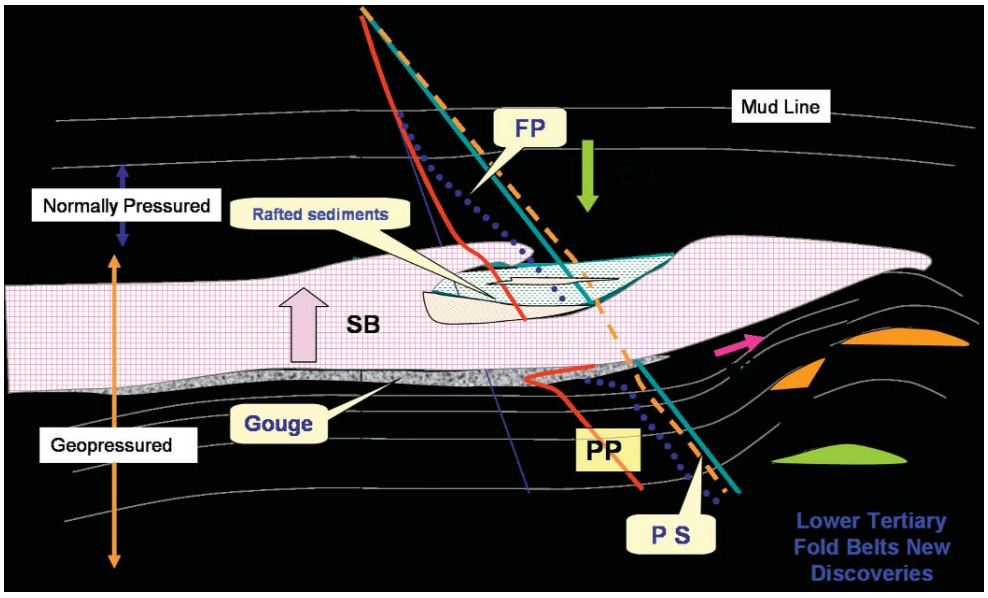
by ***Selim Shaker***
Geopressure Analysis Services, Inc. (G.A.S.)

The high rewards of finding hydrocarbons in sub-salt plays in the deepwater mini-basins and frontier salt toe belts make it very attractive for exploration endeavors. However, complex subsurface geopressure can cause hydrocarbon breaches and recurrent drilling challenges that drastically increase the operation costs of reaching the objective targets.

After the discovery of Mahogany Field, fifteen years ago, special attention was directed to the sub-salt plays and gradually shifted from the shelf to the deepwater. The striking success of the Jack prospect along the Sigsbee Escarpment (salt toe) gave hope for a substantial replenishment of national petroleum reserves. Deepwater (>1000-ft water depth) yearly production increased from 21 mmbo and 33 bcfg in 1985 to 339 mmbo and 1.1 tcfg in 2006 (MMS). The presence of intricate geopressure compartmentalization in a salt environment, deep mud line, increased target depth and shallow sediment hazards in this more challenging environment has resulted in dramatically increased costs to acquire and test prospects.

While a great deal is known about salt body delineation from geological and geophysical data, this presentation addresses salt-related risk assessment from a geopressure standpoint.

In the Gulf of Mexico (GoM) Tertiary-Quaternary system, geopressured sediments are caused mainly by compaction disequilibrium phenomena. Lithology and maximum principal stress essentially control this process. Salt's unique petrophysical properties contribute to substantial changes in the pore-pressure gradients. Its low density is responsible for retarding the overburden gradient below the salt and, conversely, enhancing it above the salt. The negligible permeability of salt creates a perfect seal. The salt's ductile nature substantially dictates the path and magnitude of the subsurface stress cage. Consequently, it impacts the integrity of the sealing caps and retention capacities to trap oil and gas in a specific structural closure.



Newly developed supra- and sub-salt geopressure models were established based on several fields and dry hole data in the GoM. In each case history, these models

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substantiate the premise that the impact of interaction between salt and sediment is an essential part of risk assessment and post-drilling appraisal.

The benefits and low-risk attributes of sub-salt plays are due to the following:

- Salt enhances the retention capacity in the sub-salt and the sealing capacity in supra-salt.
- Large reserves are trapped by less faulted sub-salt structural closures as a result of salt swells in the mini-basins area.
- High sealing capacity of the thrusted fault system characterizes the salt toe belt fairways.
- Good flow rates occur due to the high permeability of the younger sediments (Plio-Pleistocene), particularly above the salt.
- Drilling does not require high mud density to reach objective targets.

On the other hand, high risk and challenges are also present:

- Drilling problems (pressure kicks and shallow water flow) can occur above the salt due the high principle stress and pressure gradient. Several casing points may be needed to drill through this zone.
- Drilling problems are common at the salt-sediment interface at the base of the salt, especially in the gouge zones.
- The moderate to weak pressure gradient and sealing capacity below the salt can be a substantial cause of seal failure and weak water drive in the production phase.
- Sub-salt seismic imaging quality and accuracy are compromised.
- Low-permeability reservoir as encountered in the Wilcox-equivalent formations is the new frontier sub-salt play.

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Biographical Sketch

Dr. Shaker has over 30 years in the oil industry. His recent work has been focused on the Shelf and Deepwater of the Gulf of Mexico; however, he has worldwide exploration and exploitation experience in Egypt, NW Australia, Algeria, Libya, North Sea and China.

After retiring from Phillips Petroleum Company in 2000, with 20 years of service, he established Geopressure Analysis Services, Inc. (G.A.S.). The company's primary services focus on pore pressure prediction and risk assessment based on geopressure compartmentalization and seal integrity. Building the geological foundation for pore pressure prediction is his exclusive specialty. As a pioneering geoscientist, he has been the first to recognize:

- Geopressure transgression and regression due compartmentalization
- The disparity between predicted pore pressure and measured pore pressure.
- Supra and subsalt geopressure models
- Pitfalls of converting oore pressure from psi to ppg mwe in reservoir beds
- The qualification of centroid phenomenon in the subsurface geopressure.

His new method of NCT (normal compaction trend) calculation will eliminate serious mistakes and mishandling of pore pressure prediction modeling.

He has published several papers and articles regarding pore pressure predictions and the impact of geological settings on subsurface geopressure profiles (see list at www.geopressure-analysis.com).

Selim S. Shaker is Director of and Consulting Geologist for Geopressure Analysis Services, Inc. (G.A.S). He received a BSc (honor) in applied geology and MSc and PhD (1973) in geology from Assiut University, Egypt. He also received a diploma in hydrogeology (1975) from Prague University (UNESCO).

He is an active member of AAPG, Society of Exploration Geophysicists (SEG), Houston Geological Society (HGS), Geophysical Society of Houston (GSH), Geological Modeling Society of Houston (GMSH) and AADE (American Association of Drilling Engineers).