

## Pressure Trends in Lower Viosca Knoll and Mississippi Canyon, Gulf of Mexico Deep Water: Implications for Seals, Column Heights and Hydrocarbon Migration

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**A**nalysis of pressure data from forty-one deepwater wells in the northern Gulf of Mexico has revealed consistent patterns in the rates of increase of both pore pressure and fracture gradient with increasing depth. Several conclusions may be drawn from these patterns, including:

Pore pressure (PP) and fracture pressure (FP) trends are not parallel with increasing depth. PP and FP converge at the mudline. The small differences between pore pressure and fracture pressure in the shallow section of a well directly influence the openhole drilling distance allowable between casing sets. In addition, these close tolerances can exacerbate problems in controlling shallow water or gas flows that may be encountered.

Pore pressure is elevated above a “normal” hydrostatic trend at shallow sediment burial depths. Indications are that top seals form with as little as 1500’–2000’ of sediment burial. Such early seal formation is favorable to the formation of stratigraphic traps. It also sets a maximum depth for conventional riserless drilling.

Pore pressure and fracture pressure trends diverge with increasing depth in sedimentary sections with high sedimentation rates. This divergence,  $DPP < DFP$ , directly limits the column height. As the difference increases, the maximum column height possible also increases.

Conversely, pore pressure and fracture pressure converge,  $DPP > DFP$ , in deeper

sections associated with lower sedimentation rates and unconformities. As a result, maximum possible column heights decrease in these intervals and may actually preclude sealing any significant volumes of hydrocarbons.

These trends of increasing/decreasing sealing capacity have application to models of generation, expulsion, primary and secondary migration and accumulation of

were observed in all the wells analyzed. Implications drawn from these patterns extend beyond the original drilling-related focus of the project to include influence on column heights, sealing capacity and hydrocarbon migration issues.

### Methods

Pressure data were compiled for the existing wells in the area prior to Amoco initiating its drilling program in 1992. As additional wells were drilled they were included in the database. The data collected included direct pressure measurements from drill stem test (DST) and repeat-formation (RFT) or modular-dynamic (MDT) testing tools with pressure equivalents from drilling mud weights and associated leak off tests (LOT). In addition, pressure estimates from empirical relations of travel time and resistivity were applied to acoustic and resistivity logs. The acoustic algorithm was also applied to seismically derived velocity profiles from migration before stack (MBS) data for pre-drill pressure prediction.

All the data were analyzed using PRES-GRAF, a proprietary PC-based program that allows analysis and presentation of pressure data of various types and from multiple wells (Traugott, 1997). The methodology employed was first to create a calibrated pressure profile for known wells and then to extrapolate the profile to new drilling locations, usually using MBS seismic data. A plot from a typical well is presented in pressure (psi) vs. depth (Figure 2) and mud-weight vs. depth (Figure 3).

First an overburden trend (pressure vs. depth) was created for an existing well. There are two components to overburden in deepwater. First, the water column

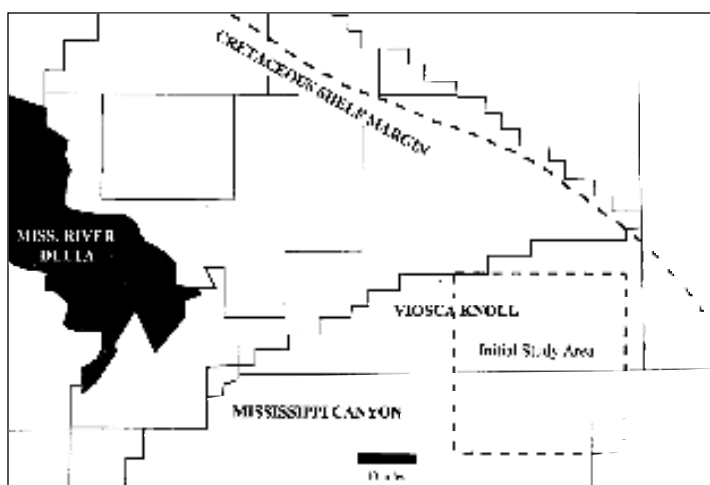


Figure 1: Index map of study area.

hydrocarbons in this area. Areas of reduced sealing capacity in the deeper sedimentary section will “frac,” allowing vertical migration of fluids to zones with higher sealing capacities.

### Introduction

Pore pressure trends were analyzed in forty-one wells to support deepwater drilling activity, particularly in the Viosca Knoll and Mississippi Canyon protraction areas (Figure 1). The goal was to predict pressure cells as an aid to well design, prior to drilling, because of the high costs of deepwater operations. Pressure trends were analyzed to define regional patterns of pressure increase with depth. As this effort continues, a number of characteristic patterns in the relative rates of increases of pore pressure and fracture pressure