pressure (water depth x 0.455 psi/ft). The average lithostatic pressure component was established using the density log from the well. Total overburden at any depth below mudline is the sum of the water column and lithostatic overburden components. Estimates of the overburden trend can be compared to measured LOT data which imposes a boundary condition on the estimate.

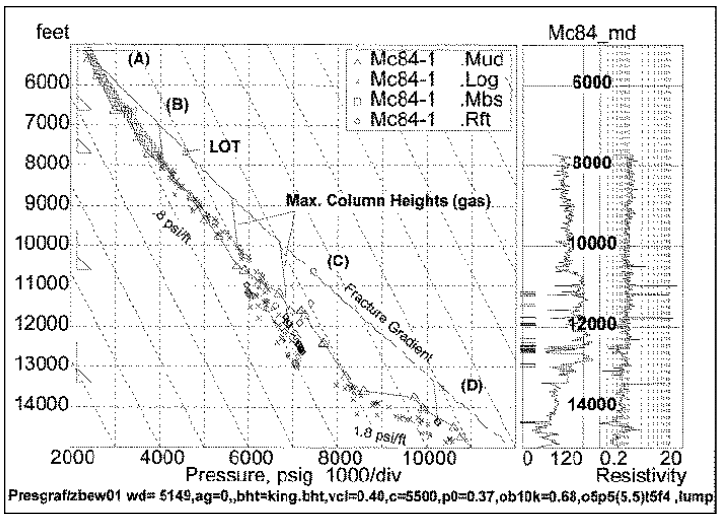

Figure 2:. *Pressure (psi) versus Depth (ft.) for a typical well, MC 84*

Second, after establishing an overburden trend, measured pore pressure data from DST or the RFT/MDT log was input. Mud-weight and LOT data was also input at this time. These measured values set boundary conditions on subsequent estimates of pore pressure created from wireline log data.

Sonic log data were incorporated next and was processed iteratively with a pressure estimating algorithm within PRESGRAF. The general relation of the algorithm is: pore pressure (PP) is proportional to travel time (DT), porosity at the surface/ mudline (P_o), volume clay (V_{cl}) and a compaction constant (C).

$$PP \mu DT \times P_o \times V_{cl} \times C$$

Some of these values may be estimated from log or geotechnical core data (Vcl, Po). The others are varied iteratively to produce a result that conforms to the pre-existing boundary conditions imposed by mud-weight and measured pressure data.

Finally, an independent estimate is made using the resistivity data. Though it uses a different algorithm than the sonic estimate, a number of variables are common to both; P_o, V_cl and C. The new variables in the resistivity estimate are resistivity (RT) and the cation-exchange-capacity (CEC). A temperature profile for the well is also necessary due to the variations in RT with temperature. The resistivity estimate is computed and compared to the sonic value. The two algorithms are solved iteratively until a close match is achieved using common values for P_o, V_{cl} and C.

Once a calibrated model was created for a known well, that model (with adjustments for variations in water depth) was used for pre-drill estimates of pressure for new drilling locations. The sonic algorithm was especially useful for pre-well locations that had MBS seismic. A velocity profile extracted from the MBS velocity volume can be processed in a similar manner to the sonic log. This gives a direct pre-drill estimate of pressure at the well location. Seismic velocity uncertainty will propagate through the model as a resultant uncertainty in the absolute estimated pressure, however the rates of change in estimated pressure and any associated inflection points in the pressure profile, have significance in establishing depths to major pressure cell boundaries.

During drilling operations, the calibrated resistivity model values may be applied to measured-while-drilling (MWD) resistivities to evaluate pressure trends in the well in real time.

Condusions

Several general conclusions can be drawn from the data. Most are easily extrapolated to other areas in the Gulf of Mexico offshore and to other clastic, passive margin basins. Others are currently specific to the geology of the local area, and cannot yet be extrapolated to other areas.

Fracture pressure and pore pressure trends converge near the mudline (point "A" in Figures 2 and 3). This convergence sets a physical limit on the amount of open-hole that can be maintained before setting additional casing strings becomes necessary. In this shallow section below the mudline, more time and expense are expended setting and cementing casing than in drilling.

These narrow tolerances, typically a few tenths of a pound-per-gallon (PPG) equivalent, between PP and FP can make control of shallow pressure flows difficult. While increasing mud weight to control flows a slight overbalance can break down formation causing loss of drilling fluid. After this loss, the flowing formation comes back into the well. This cycle of flow/ kill/breakdown/ flow can result in substantial well cost overruns.

Seals form earlier and at shallower depths below mudline in the deep water environment compared to shelf sediments (point "B" in Figures 2 and 3). Water column is a contributing factor, with the water column providing an overburden stress approximately equivalent to a column of rock half this thickness. The water column effect is most noticeable in water depths exceeding ~2000'. Pore pressures are elevated above hydrostatic pressure with as little as 1500'–2000' of sedimentary overburden deposited. This early top-seal formation sets up a favorable system to trap early migrating hydrocarbons. The study area has a relatively large number of fields/discoveries with significant stratigraphic components.

Pore pressure and fracture pressure increase at different rates with increasing burial depths. These differential rates of pressure increase result in variations of potential column heights with increasing depth. In the younger, expanded Miocene sections, characterized by high sedimentation rates, the rate of pore pressure increase is lower than the increase in fracture pressure (DPP< DFP). In the deeper, older section there are transitions into higher pressure cells where the rate of change in pore pressure is higher than the

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