AAPG International Conference
Barcelona, Spain
September 21-24, 2003

Thomas Finkbeiner[1], Mark Zoback[2], Peter Flemings[3], Beth Stump[4] (1) GeoMechanics International, Mainz, Germany (2) Stanford University, Stanford, CA (3) Pennstate University, University Park, PA (4) ChevronTexaco, New Orleans, LA

In Situ Stress and Pore Pressure Dynamically Control Fault Seal Behavior of a Gulf of Mexico Reservoir

Hydrocarbons in the OI-1 sand in the South Eugene Island 330 Field, northern Gulf of Mexico, are trapped by a Plio-/Plistocene growth fault system. Pore pressures in the reservoir at the top of the structure are noticeably higher than porosity-based pressure predictions for the adjacent shale. In addition, the water phase pressures within these reservoirs vary markedly in different fault blocks although they tie to a common aquifer. These pressure differences correlate directly with gas and oil column heights and peak pressures at the top of the sands. Fault blocks with relatively lower water phase pressures show long hydrocarbon columns (i.e., oil and gas) that appear to have reached a maximum height that is statically controlled by a down-dip spill point. Fault blocks with markedly higher water phase pressures show relatively shorter oil columns and relatively higher overpressure at the top of the sands that are within 92% of the least principal stress. We propose that the hydrocarbon columns in these fault blocks have reached a dynamic equilibrium by which maximum column height is controlled by a critical pore pressure that can breach the fault seal through dynamic shear failure. Because the fault seal is in dynamic equilibrium with fault strength any addition of hydrocarbons would increase the pressure at the top of the sand, cause the fault to slip, and result in upward fluid migration like a dynamic fault valve: it opens at sufficiently high pressure but regains its seal capacity after hydrocarbons are released and pressure drops.