Pore Pressure Prediction Using 3-D Seismic Velocities and Well Data in Deep Water Eastern Niger Delta

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Pore Pressure Prediction (PPP) studies provide key information for well planning and safe drilling, which generally add value to both exploration prospect risking and appraisal well proposals. PPP methods are commonly based upon information from basin modeling, well log modeling and seismic velocity modeling.

In this paper, an integrated approach is demonstrated which predicts pressures below known well depths from measured pressure data, checkshots, seismic interval velocities and geological interpretation, covering the eastern Deep Water Niger Delta. Conditioned petrophysical well logs, measured pore pressure, checkshots, quality-checked semblances and seismic interval velocities were integrated into a PPP workflow. An Earth velocity cube was derived by calibrating the seismic interval velocity to the well checkshots.

Total vertical stress/overburden stress, normal compaction trends and shale velocity trends were generated from the volume of shale, density and sonic velocity logs. Prediction points were picked within the shale intervals. The predicted pore pressures in the shale, using Eaton's approach with an exponent of 3, compared favorably with the measured pore pressure trends in the sand. Vertical effective stress (VES) and overburden pressure versus velocity transforms were derived for the shales. The results of VES - velocity and density - velocity cross-plots analysis from the wells, indicates disequilibrium compaction within the study area. The seismically derived pressure cubes indicate a strong geo-pressure anomaly below the mapped Oligocene level. Regions with likely low pressure seals were identified which corresponded to regions of intense faulting; in some of the regions a north-south trending fault extends to the surface of the sea floor acting as pressure release valves. Amplitude extraction on the sea floor horizon supports this interpretation.