The influence of rock age, sedimentation rates and temperature on depo-centre pressure profiles, Onshore Niger Delta


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ABSTRACT

The onshore Niger Delta is divided into a series of depo-belts (Upper Miocene, Middle Miocene, Oligocene-Lower Miocene and Eocene). Well density data shows highly overpressured, low porosity shale is present at similar depths within each individual depo-belt, but the actual depth to these low porosity shales varies between belts, with low porosity occurring shallower, the older the depo-belt. This may reflect depositional cycles of the Onshore; however, there is a relationship between temperature, pressure and stress as well. High density, low porosity shales are not typically associated with disequilibrium compaction, and, indeed, evidence is present for both elastic and inelastic unloading in these shales. In the Upper Miocene depo-belts, where sedimentation rates are the highest generally, disequilibrium compaction is more dominant, despite temperatures of 150°C.

Shale pressure prediction models were developed for each depo-belt, utilising relationships between velocity and stress, using 37 wells. 25 blind test wells were analysed; the resulting shale pressure predictions gave results close to observed drilling history and matched kicks encountered. Maps were produced based on generated sets of velocity/stress plots showing temperature at which “unloading” appears. These maps were used to guide where loading and unloading modes were switched to produce pressure profiles. Hence for any un-drilled location, using nearest-well, known or progessed temperatures, allows for an estimate of shale pressures (and if un-drained, also reservoir pressures) can be produced.

Historically many wells in the Onshore Niger Delta have terminated drilling at the occurrence of the first kick. These models will allow for a more robust understanding of shale pressures, allowing wells to reach their planned termination depth on a regular basis. This becomes even more critical as current wells are drilling to depths of over 20,000 feet below the surface in true HP/HT conditions and are hence very expensive.