Pore Pressure Regimes in Tertiary Deltas

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In a typical modern delta the inboard shallow sedimentary sequences are composed of progradational deltaic, reservoir dominated sediments which are normally pressured (Regime A). In the Mississippi Delta, Gulf of Mexico, normal pressures are known to depths in excess of 4.0km, on account of a high sand/shale ratio. The Benin Formation and some portions of the Agbada Formation sediments correspond to Regime A in the Niger Delta. Beneath Regime A sediments a strong pressure transition zone is expected, with attendant challenges for pre-drill prediction and safe well planning. Shale-prone sediments, both shallow (e.g. on continental slopes) and deep (e.g beneath Regime A) which have been isolated from fluid escape by low-permeability shales correspond to Regime B, which is characterised by having high overpressures. Pressure prediction in Regime B works satisfactorily if reservoirs are limited in their vertical relief and/or there are no open faults connecting stacked or cross fault reservoirs. Where temperatures exceed approximately 100-120^{o}C additional pressure generation mechanisms commence (Regime C). These processes influence rock properties, notably porosity, thereby requiring modification to the standard rock property-effective stress relationships used to predict pore pressures. Finally where reservoirs are connected within the delta (perhaps laterally draining to the surface, or confined within low-permeability sediments but with high relief) lateral fluid movements once again render traditional approaches to shale-based pore pressure prediction more challenging. Regime D can therefore be found at any depth range. Parts of the Baram Delta, offshore Brunei, exhibit classic Regime D characteristics (both unexpected high and low pressure regimes).

The purpose of this paper is not to add additional classification and terminology to delta settings but to alert the wider geoscience and drilling communities of the challenges of pore pressure prediction in Tertiary deltas such as the Niger Delta, Nigeria, and to dispel some of the prediction myths in such settings. A major pressure study is underway to examine the distribution of pressure regimes in the deep-water Niger Delta, and to explore related issues such as laterally drained reservoirs and associated hydrodynamically controlled hydrocarbon distributions, effects of horizontal stress on overpressures in the toe-thrust region and seal breach analysis.