Multiple Bottom Simulating Reflectors and Multi-Stage Fluid Migration Related to Cyclic Tectonic Activity in the Deepwater Niger Delta

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ABSTRACT

Using high resolution 3D seismic data, we present acoustic evidence and the character of multiple bottom simulating reflectors (BSRs), including the first report of a Relict BSR occurrence in the Niger Delta. The occurrence and character of the BSRs provide insight into multi-stage fluid migration and hydrocarbon phase changes related to cyclic tectonic activity. Three laterally extensive equilibrium-state bottom simulating reflectors were interpreted in the crest of thrust related anticlines. The BSRs mark the base of the hydrate stability zone in the Field. Acoustic blanking of large sections of the seismic data volume coupled with the occurrence of shallow perched enhanced seismic amplitude reservoirs and multiple seismic chimneys indicate the hydrate zone receives a profuse supply of thermogenic gases from deep reservoirs. Gases migrate from the Akata/Agbada boundary through major thrust faults at depth and normal faults and permeability zones in shallow sections. The hydrate zone acts to incorporate rising fluids as hydrates in near surface sediments and further serves as a temporary barrier, trapping free gas beneath the hydrate zone. Free gas beneath the hydrate zone is channeled to focused flow conduits for intermittent release at pockmarks on the seafloor. The multi-stage migration of fluids relates closely to recent tectonic activity involving alternations between rapid uplift on thrust anticlines and tectonic quiescence associated with sub-aerial erosional episodes. The Relict BSR occurs beneath the most outboard equilibrium-state BSR and has an apparent tilt in the hinterland direction. We believe that the Relict BSR represents the base of the hydrate zone in the recent climatic past which is still in the process of dispersing. Temperature modeling results, rule out the possibility of hydrates at the Relict BSR position. The reflection polarity of the BSR, weaker reflection amplitudes relative to the shallower equilibrium-state BSR and an apparent hinterland tilt relative to the upper BSR, support this conclusion. We aver that the recent uplift on the thrust systems greatly reduced the height of the water column and over burden pressure above the fold resulting in dissociation of hydrates at the base of the hydrate zone and its consequent upward shift, leaving behind a Relict BSR. We reckon that the hinterland tilt of the Relict BSR, relates to the rotation of the fold limb during this uplift episode.