Petroleum Geology of Deep Water Areas in the Gulf of Mexico and Offshore Nigeria: Miocene Deltas, Ductile Shale and Salt Tectonics of Frontier Regions for the 21st Century

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Over the last decade, the exploration economics of deep water offshore Nigeria (DWON) and the deep water Gulf of Mexico (DWGM) have improved dramatically, making possible a new generation of 2-D and 3-D seismic and accelerating drilling programs. Recent discoveries in both basins (e.g. Bonga, Ngolo and Adaku fields in DWON and Diana, Mensa and Neptune in DWGM) have re-ignited enthusiasm for understanding the geology of these distinctive hydrocarbon provinces. In DWGM, three major plays are being made: 1) slope basin flanks, 2) subsalt and 3) fold-thrust belts. These plays have their counterparts in DWON with the exception that DWON is salt-free. New 15 second record data from the DWGM suggest that oceanic crust underlies much of the original basin in which up to 4 km of Jurassic salt was initially deposited. There is little or no evidence for significant basement "sills" or typical half-grabens associated with rifted continental crust. The seaward edge of salt that marks the end of the fold-thrust belts was originally controlled by establishment of open oceanic circulation during the last stages of sea-floor spreading. Thin sediments of Jurassic through Oligocene age overlie the salt and were subsequently deformed during the ductile salt deformation accompanying Miocene and younger shelf progradation. Primary target reservoirs are thin-bedded turbidites with surprisingly high porosity and delivery rates. In DWON, ductile shale of Cretaceous age underlies the entire deltaic complex. Production onshore and from the shelf has largely been from paralic facies associated with rapid seaward progradation during the Miocene. DWON production differs in that reservoirs are turbidites deposited primarily during sea-level lowstands penecontemporaneous with intense canyon-cutting through the older deltaic complex. Structurally, mud diapirs and imbricate thrusts are clearly defined in new regional seismic grids. Younger deformation in both DWGM and DWON is largely extensional, characterized by major growth fault complexes and abundant counter-regional faults. In both basins, initial geologic models predicted lack of sand and gas-prone source rocks. In contrast, both have now been shown to be sand-rich with some new oil reserves in the 100-500 million barrel range. The next century will see widespread exploration and production in both provinces in water depths unheard of only a few years ago.