Distribution Patterns of Porosity and Permeability in the Hydrocarbon Bearing Sands of the Agbada Formation, Niger Delta Continental Shelf, Nigeria

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Based on the wealth of subsurface data generated by the oil and gas industry in Nigeria, the characteristics, variability and distribution patterns of porosity and permeability were analyzed for the reservoir sands of the Agbada Formation, Niger delta continental shelf, to provide the much needed information for its prediction during exploration and development of subsurface hydrocarbon. Investigation depth ranges from 5000 feet to 16,000 feet, spanning the currently known hydrocarbon-bearing interval in the region.

This study shows that a wide range of porosity and permeability values characterizes the reservoir rocks. Porosity ranges from 3.6% to 39.4%, a mean of 21.92%, standard deviation of 8.91. The horizontal permeability ranges from 0.08 to 9990 millidarcy, mean of 1005.81, standard deviation of 1948 while vertical permeability range from 0.01 to 7940 milidarcy, a mean of 606.5 and standard deviation of 1341.5.

There is an overall decrease of porosity with increasing burial depth at a rate of 2% every 1000 feet at the shallower level, lowering to 1-1.5% at greater depths (>12,000 feet). For a composite sandstone sequence representing a wide range of depositional environment and subsequent diagenetic histories, all regression models (Linear, power-law, logarithmic, and exponential) predicts porosity reasonably well at intermediate to deeper depths. At surface of deposition to depths of about 5000 feet, linear model is the only viable predictive model. Porosity shows a strong linear relationship with clay content of the reservoir and log and/or power-law relationship with quartz content of the reservoir sands. Horizontal permeability (Kh) shows more or less log relationship with clay content and power-law relationship with quartz content of the reservoir sand. Permeability is highly variable and showed no marked relationship with depth.

A porosity of about 44% is hypothesized in this study as the initial porosity of the reservoir sands of the Niger Delta continental shelf at the time of deposition some millions of years ago. Predictive capabilities of the petrophysical properties of porosity and permeability in the Niger delta will decrease the number of well tests and core analysis required to obtain rock property distributions for geological modeling.