Paper Number: 3606

Geostatistical Modelling of Log-derived Petrophysical Data for Quantifying Uncertainties in "AMESERE" Field, Niger Delta

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Adequate representation of reservoir heterogeneities presents a significant challenge in reservoir model building. Reservoir models are often too homogeneous, thus making geologic reality not only difficult but sometimes less predictive, monotonous and unreliable for hydrocarbon potential estimation and production planning.

In this study, Geostatistical inversion of some hydrocarbon reservoir parameters from a suite of borehole logs in "AMESERE" field, Niger delta was undertaken. This was with a view to modelling the sampled petrophysical data with their spatial variations for detailed high-resolution heterogeneity models of the reservoirs across the study area.

Well logs from 24 wells within the field were correlated and RES_2 reservoir was selected for the computation of petrophysical parameters including (water saturation (Sw), Porosity (Φ), gross reservoir thickness and net pay. A 3-D Cartesian grid was created to allow the discretization of the reservoirs into cells to support and contain generated petrophysical data which are irregularly distributed over the study area. Average deterministic estimation maps and exponential variogram model of the petrophysical data were produced and used as inputs for Sequential Gaussian Simulation (SGSIM), an inversion algorithm, for the simulation of the petrophysical data to produce thirty (30) equally probable realizations. These showed different plausible results (realizations) that were consistent with the petrophysical data.

Statistical summary in RES_2 reservoir showed a mean porosity before and after simulation of all realizations to be 25.87 and 25.55 %; mean lower and upper quartile were 21.87 and 29.18 % respectively. Mean Sw before and after simulation for all realizations were 41.80 and 44.46 %, mean lower and upper quartile were 29.23 and 59.29 % respectively. Mean Gross reservoir thickness before and after simulation for all the realizations were 16.12 and 16.79 m, mean lower and upper quartile were 14.06 and 19.5 m respectively. Mean of Net pay before and after simulation for all realizations were 7.16 and 8.03 m, mean lower and upper quartile were 5.25 and 10.81 m respectively. Realizations ranking was used to select a few individual realizations, typically a pessimistic, median and optimistic case (P10, P50 and P90). In Res_2 reservoir , porosity at P10, P50 and P90 was 19.8 %, 29 % and 31.6 % respectively; Sw at P10, P50 and P90 was 21 %, 44.8 %, 68.4 % respectively; Gross thickness at P10, P50 and P90 was 12.15 m, 17.05 m, 21.5 m respectively; Net pay at P10, P50 and P90 was 4 m, 8.45 m, 12.4 m respectively.

This work presents a simple and unique technique to account for heterogeneities and uncertainty quantifications in reservoir models. The statistical distribution of the raw petrophysical data

and the data from realizations after the simulation showed a reasonable correlation. The combination of the averaged deterministic and geostatistical modelling methods to characterise the RES_ 2 reservoir provided a robust spatial understanding of sub-interwell heterogeneity which was responsible for the uncertainty in the reservoir. The pessimistic, median and optimistic case (P10, P50 and P90) are recommended for consideration as inputs for calculation the Original Oil in Place (OOIP), to making cautious investment and drilling decisions over the field.