4-D Monitoring: Example of 4-D Interpretation in Lower Flanks Systems, Dalia - Angola

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Lower Flank is located in eastern part of Dalia field, deep offshore Angola,of Miocene age. It is mainly composed of unconfined turbiditic deposits formed by different lobes separated by shaly deposits. After 1½years of production, a first 4D seismic survey was shot on all Dalia area in order to understand the reservoir communications inside heterogeneous turbidites channels deposits. The 4D effects seen on Dalia are large in time shifts with above 10ms.Advanced interpretation techniques were used to interpret 4D signals and upscale them inside the reservoir model.

The aim of the 4D interpretation on Lower Flanks is to interpret the 4D anomalies present due to production. For this purpose, TOTAL performed in house the warping tool that is an inversion approach (Williamson et al, 2007) to generate amplitude difference and dV/V attribute from Base and Monitor survey corrects from time shift which is large. We compare 4D anomalies to facies extension limits, with additionally 3D Bandpass IP derived from pre-stack inversion and Architecture Element(AE)map, to see if the geological model is predictive or not.

According to the Lower Flanks systems, the 4D interpretation is performed by picked the 2D seismic boundaries on isoproportionnal layers and compared visually to water saturation and fluid pressure obtained from reservoir simulation. We were able to detect the following 4D effects: Depletion-in-Oil around producers (-dV/V signal); Water-in-Oil around injectors and on WOC rise up (+dV/V signal);Water-in-water around injectors (-dV/V signal) due to salinity effects.
We used dV/v attribute constrained to propagate 3D geobodies in order to have reliable 4D anomalies that must be 4D anomalies are consistent with geology by comparing 4D anomalies to 3D impedances and AE map upscaled inside reservoir models. Then, we upscale 3D geobodies extensions of water injection, depleted areas in fine geological grid of 40X40m, where facies and petrophysical parameters can be updated according to 4D anomalies extension.

Within this volumetric 4D interpretation, we are able to make reservoir models more predictive for the future since we confront geological and dynamic knowledge at the same scale in 3D. At same time 4D helps us on the fault sealing behaviour comprehension since some 4D effect is seen along faults and help us in changing some fault transmissibility inside the reservoir model. It is useful to understand the vertical/lateral communication between the lobes and other complexes.