4D Pilot integrated interpretations in Al Khalij carbonates field, Qatar

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ABSTRACT

Successful application of time lapse (4D) seismic monitoring has been predominantly offshore in thick clastic reservoirs. In this paper we describe the application of time lapse seismic methods to Al Khalij Field which presents fractured carbonate <5m thick interbedded with tighter layer of muddy facies. The objective of this study was to verify that 4D signals were linked to depletion effects and/or that water sweeping were detectable. Following a feasibility study done in 2011, a 4D pilot has been acquired in 2012 along 2 swaths. 4D data couple (base and monitor data) was post-processed with strong denoise filter (FKF3D + SCFIL) in order to minimize the impact of striping and multiples. This was followed by a Warping process in Sismage^{TM} (TOTAL in-house software) with optimized parameters which delivered 4D dV/V and dIp/Ip attribute and realigned monitor cube.

4D seismic data is in line with DSTs, MDTs, RCIs and other dynamic data in the field. Best examples are in L0 interval of swath 1 and L3 of Swath 2. These show the ability of the 4D data (dV/V; dIp/Ip) to highlight depleted and pressurized areas, flow corridors and heterogeneities. PVT study on aquifer of the field had shown gas bubbles could be created in the aquifer linked to depletion which can lead to negative 4D dV/V anomalies. By overlaying 4D attributes with a specific seismic attribute (Gradient Coherency) it was possible to infer possible conductive, flow baffles and limiting fractures.

Main highlights of the 4D Interpretation are summarized below:
• 4D data was very noisy due to low quality baseline and presence of multiples. Some post processing denoise filter had to be implemented to minimize the impact of striping and of 4D random noise.
• Three main effects were interpreted:
- Pressure changes: depleted zones as dV/V>0 and dIp/Ip>0.
- Saturation changes: injected water front, possible evolution of water as dV/V>0 and dIp/Ip >0
- Effects of gas coming out of solution as a result of depletion in hydrocarbon/water seen as dV/<0 or null effects where it is compensated for by depletion effects.
These are key results for planning the next development phases on the field. They also depict that only a parallel analysis of all parameters and crosschecking with geological/reservoir data allows pinpointing the different dynamic phenomena, i.e. that the 4D interpretation requires a highly skilled integrated team.