Time-Lapse Prestack Seismic Inversion to Delineate Un-Drained Reservoirs – Simian Field, Offshore Nile Delta, Egypt

Wael S. Said[1], Islam A. Mohamed[2], and Abdulrahman Ali Mohamed[3]

[1]Badr El Din Petroleum Co. (EGPC and Shell Egypt Joint-venture), Cairo, Egypt.
[2]RASHPETCO, Cairo, Egypt.
[3]Geoscience and Professional Engineering Solutions, Cairo, Egypt.

ABSTRACT

The Nile Delta Basin is a productive gas province, which has been under exploration and development for decades. Even though the basin has been studied widely using geologic and geophysical methods, mapping un-drained sweet spots from seismic data still one of the major challenges. The main driver to acquire time-lapse seismic over the Pliocene gas fields was to identify additional development opportunities by imaging hydrocarbon drainage patterns or pressure depletion. As feasibility studies promise 4D signals over these reservoirs and dynamic versus static volume discrepancies indicated that the remaining opportunities are good enough. As the upcoming drilling campaign is targeting the remaining volumes of one of the Pliocene reservoirs in the offshore Nile Delta "Simian field", this study compares different vintages of seismic data shot over the WDDM concession in the search for 4D effects attributable to changes in reservoir conditions due to production. The seismic data used were the 2006 survey as a base survey and the 2014 survey as a monitor survey. As these datasets were not acquired or processed as a 4D survey. Reprocessing of the seismic datasets was required in order to distribute the data onto a common grid. The common grid used was that of the 2014 survey. The two surveys were matched in terms of amplitude, phase and timing through the use of filters. This was done in a global, local and residual sense, with each matching stage becoming more intolerant of differences. The design of matching filters was conducted away from producing fields (Scarab-Saffron). As part of the reprocessing, the 2006 survey data bandwidth was enhanced and noise reduced. Partial angle-stacks from the base and the monitor surveys were separately inverted to the acoustic impedance (Zp), shear impedance (Zs), and density. The analysis of the individual inversion results and the 4D differences indicated that the liquid gas throughout the field was widely exploited. The production history of the wells was found to be consistent with the lower Vp/Vs ratio and the higher Zs values indicating depletion. This is in agreement with the modeled response predicted by the feasibility study, due to changes in reservoir pressure and saturation. Both Zp and Vp/Vs are affected by pressure changes as well as saturation changes, while the Zs was found to be the most reliable pressure-changes indicator.