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A Seismic Case Study in Southern Iraq: From 3D Acquisition to Seismic Characterization of Mishrif Reservoir

F. Luoni* (eni), A. Amato del Monte (eni), C. Chinigo (eni), A. Corrao (eni), M. Fervari (eni), S. Miraglia (eni), J. Rodrigues (eni) & E. Sanguinetti (eni)

SUMMARY

This paper provides an overview on the geophysical experience gained in Southern Iraq from seismic acquisition to seismic reservoir characterization to support the development of Mishrif reservoir.

Introduction

A 3D seismic acquisition, covering a giant oil Field, was completed in Southern Iraq. The 3D survey (1723 sqkm single fold area) was acquired 90% with vibroseis, in the southern and central part of the Field, and 10% with dynamite in the northern swamp land.
After data processing, the ensuing interpretation phase comprised a number of G&G works, carried out with the main goal to deliver information to be integrated into the reservoir model.

Seismic Acquisition and Data Processing

Although the main target of the acquisition was the Lower Cretaceous reservoir section (Mishrif and Zubair producing reservoirs and Nahr Umr and Yamama undeveloped reservoirs), the survey was also designed to provide a proper illumination of possible exploration targets in the Jurassic, beneath Gotnia Fm. The challenges of seismic acquisition were related to the different environments encountered during the operations: urban areas, densely populated farmlands, military restricted areas, gas and oil infrastructures, open desert, sabkha, environmentally sensitive marshland, and archaeological sensitive sites. Moreover, due to the recent military conflicts that took place in Iraq, all of these areas were contaminated by UXO and military waste which required an heavy demining campaign to be conducted ahead the seismic operations.

The data acquired were then processed and a 3D Pre Stack Time Migration (3D PSTM) was finally delivered (pre-stack CMP gathers and full and angle stack volumes). The main challenge of seismic data processing was the effective removal of multiples still preserving the true amplitude conditions of the seismic dataset.

Geophysical studies for Mishrif characterization

The first information derived from seismic concerned the reservoir geometry (Figure 1). This was defined by depth conversion of seismic interpretation, following both deterministic and stochastic workflows. The latter was deemed necessary due to the non uniform distribution of wells in the Field which makes the reservoir structure well controlled on the crest but more uncertain on the flanks. The reservoir structural uncertainty and its impact on the Gross Bulk Volume (GBV) was evaluated by calculating hundreds of equi-probable geostatistical realizations, all of them fluctuating around the base case and honouring the well tops, and captured by structural maps depicting the P10, P50, P90..scenarios.

Geometrical seismic attributes (continuity and maximum positive and maximum negative curvature) were calculated from the full stack 3D PSTM. The continuity proved to be particularly useful, showing either large scale faults and diagenetic features in the Upper reservoir which also show a correlation with production data.

The 3D PSTM was also used in a quantitative way to predict the reservoir petrophysical properties by means of seismic inversion, rock physics and calibration of elastic attributes. Seismic inversion was run simultaneously over the entire reservoirs section and different calibration rules were applied to the reservoirs of interest.
For the Mishrif, the available well data show the well known inverse relationship between acoustic impedance and porosity of carbonates, but with a distinctive scattering which, if ignored, would make the estimation of porosity from acoustic impedance highly uncertain. Based on core analysis and samples observations, the data scattering in the acoustic domain was interpreted to be diagnostic of a different rock frame flexibility and ultimately related to different dominant pore types. According to these considerations, firstly a porosity volume (Figure 2) was derived from acoustic impedance and used as external drift for porosity modelling. Then, following an internal eni approach for Carbonate Seismic Reservoir Characterization (CaSRC), the acoustic impedance and porosity volumes were

classified into a frame flexibility facies volume which was utilized to aid the definition of the environments of deposition away from well control.

Conclusions

The seismic characterization of Mishrif, based on an high quality 3D seismic, provided valuable information for the reservoir model building. Its contribution was particularly significant to extend the well data information to those sectors of the Field where the well control is definitively more sparse.

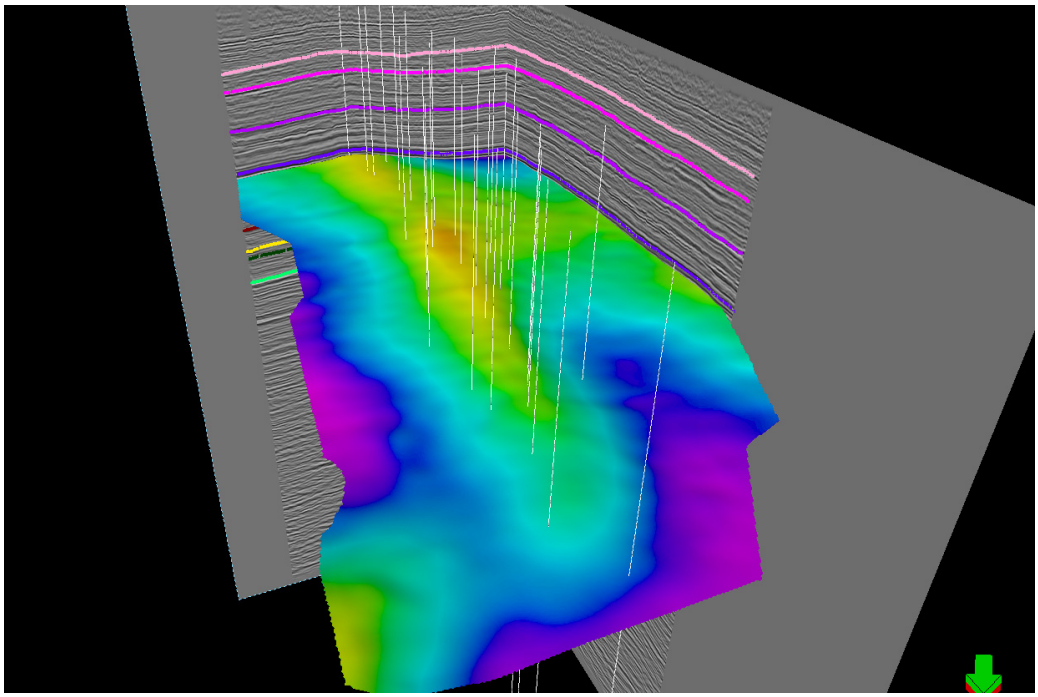

Figure 1 *Top Mishrif map after 3D PSTM seismic interpretation.*

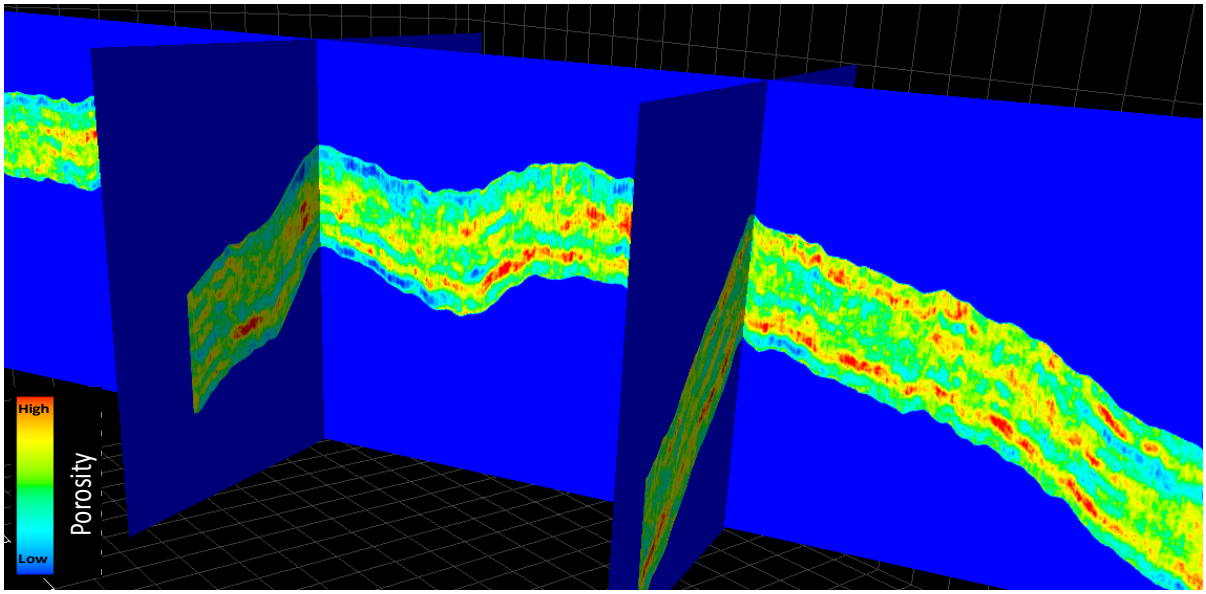

Figure2 *Porosity volume after seismic inversion.*