

## CHARACTERIZING AND MODELING NATURAL FRACTURE NETWORKS IN A TIGHT CARBONATE RESERVOIR IN THE MIDDLE EAST

Dipak Singha Ray<sup>1</sup>, Adnan Al-Shammeli<sup>1</sup>, Naveen K. Verma<sup>1</sup>, Saad Matar<sup>1</sup>, Vincent de Groen<sup>2</sup>, Ghislain de Jousseineau<sup>2\*</sup>, Thierry Le Maux<sup>2</sup> & Waleed Al-Khamees<sup>1</sup>

<sup>1</sup>Kuwait Oil Company, Kuwait

<sup>2</sup>Beicip-Franlab, Paris, 232 Avenue Napoléon Bonaparte, 92502 Rueil-Malmaison Cedex, France.

\*ghislain.dejousseineau@beicip.com

Fractured reservoirs are challenging to handle because of a high level of heterogeneity (Nelson, 2001; Bourbiaux et al., 2005). In particular, natural fracture networks have a significant impact on the reservoir performance as they affect well productivity (Narr et al., 2006). Therefore, understanding their significance through fracture characterization is helpful in well placement and field development.

This paper presents an overview of efforts in building a 3D stochastic fracture model for reservoir characterization of a Middle Eastern tight carbonate field. This model is generated in FracaFlow™ through the analysis and integration of well data pertaining to fractures like cores (including oriented core), bore hole images (BHI), well logs, mud losses, production logging and well test data together with 3D Q-Seismic data [structural and seismic attributes and seismic facies analyses (Abdul et al., 2010)].

The impact of lithology on fracture occurrence was quantified based on rock-typing and distributed in a 3D geological model using a high resolution sequence stratigraphic framework. The length, dip angle and orientation of fractures as well as the shale content of the facies where they are present were defined to sort the tectonic fractures from the non-tectonic ones. It was found that multiple sub-vertical sets of diffuse fractures are generally associated with cleaner limestone units. Altogether, three sets of diffuse fractures were identified from borehole image data: N20°E, EW and N170°E. Large-scale fracture corridors, including sub-seismic faults identified from seismic analysis, were calibrated with core and BHI fractures

through fracture data analysis workflows. The model finally incorporates two scales of tectonic fractures: diffuse fractures and large-scale fractures that have a direct bearing on well and field production behavior.

The fracture calibration was also performed using the dynamic data set such as production log and well production data. Permeability at wells was computed in the DFN (Discrete Fracture Network) model and matched with the real build-up data. These data were then used to propagate 3D fracture properties (fracture porosity, fracture permeability and equivalent block size or shape factor) in the upscaled geological model for constructing a full reservoir simulation model. The model proved to be very reliable as few changes of the fracture properties were needed to obtain a good history match.

### REFERENCES

- ABDUL, J.A., MATAR, S., CONVERT, P., ROCHER, D., DE GROEN, V., 2010. Seismic Characterization for Stochastic Modeling of Fractures in NJ-SR Reservoirs of UG Field, West Kuwait. Oral presentation #681063, Geo2010 Conference, Kingdom of Bahrain.
- BOURBIAUX, B., BASQUET, R., DANIEL, J.M., HU L.Y., JENNI, S., LANGE, A., RASOLOFOSAON, P., 2005. Fractured reservoirs modelling: a review of the challenges and some recent solutions. First Break 23:33-40.
- NARR, W., SCHECHTER, D.W., AND THOMPSON, L.B., 2006. Naturally fractured reservoir characterization. Society of Petroleum Engineers. 115p.
- NELSON, R., 2001. Geologic analysis of naturally fractured reservoirs. Elsevier. 352p.