Prospectivity of Khuff Reservoir in Southwest Kuwait

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The Permian–Triassic Khuff Formation is an extensive gas reservoir in the Arabian Gulf area. The formation houses the world’s largest gas accumulation: the combined North Field (Qatar) and South Pars (Iran) dome, contain approximately 1,500 TCF of gas (Halbouty, 2003). The formation was deposited during a regional transgression over a stable shelf of very low relief, which had minor clastic supply on the margin of Arabian Peninsula. The porosity and permeability of the Khuff carbonate reservoirs are generally very low in the entire Middle East. Ehrenberg (2007) showed that porosity in the Middle East varies from 2–14%, where the depth of reservoir varies from 2–5.5 km. To explore the Khuff reservoir prospectivity, post–stack seismic inversion and porosity modeling was carried out using recently acquired 3-D Q-Land seismic data. The study area consists of two major fields, Minagish and Umm Gudair, which are located over major structural highs. In the southwestern part of the Kuwait only one well was drilled to the Khuff-C reservoir over the structural high of West Umm Gudair Field. Here the Khuff-C reservoir occurs at greater depth and is around 350 feet thick. The observed porosity of the unit is around 2.0%. The testing of the unit could not be carried due to mechanical problem.

The principal objective of seismic inversion is to transform seismic reflection data into a quantitative rock property and is being used in the industry for better understanding of the reservoir properties and realistic assessment of oil-in-place. In the present study geological, geophysical and petrophysical data are combined through the Constrained Sparse Spike Inversion (CSSI) technique to generate an Acoustic Impedance (AI) volume. The interpreted seismic horizons and AI logs are used to create a low-frequency component of seismic inversion, whereas the band-limited information is taken from seismic data. The AI volume is generated through CSSI process. As AI is closely related to lithology, porosity and pore fluid saturation of reservoir rock, it is possible to find an empirical relationship between AI and the rock properties. Within the Khuff-C reservoir the cross-plot between AI and porosity at the well indicates an inverse relationship that is utilized in transforming AI to porosity volume.

A modeling study shows that porosity for Khuff-C layer varies from 2–3% in the study area. Porosity development corresponding to the Khuff-C reservoir shows overall better porosity development over the East Umm Gudair anticline compared to West Umm Gudair and Minagish fields. But porosity is poorly developed at the structurally highest part of the area. Careful analysis of seismic data shows some anomalous feature over the East Umm Gudair anticline. The character of seismic data is quite different from the rest of the area around the Khuff level. The data looks noisy and disturbed in this part and this anomaly does not continue in shallower level. It is interpreted that the anomaly might be associated with faulting and intense fracturing.

In view of the seismic anomaly associated with Khuff level and observed better porosity development over East Umm Gudair field, the area is recommended to be explored for Khuff-C prospectively.
Acknowledgement
The authors thank Kuwait Ministry of Energy and Kuwait Oil Company for their permission to publish this paper. The authors are thankful to Team Leader, Exploration Operation Team and Manager Exploration Group for their inspiration for writing the paper. The authors are also thankful to all members of SRPP sub unit of Exploration Operation Team. The authors are thankful to Riyasat Hussain and R.T. Arasu of Exploration Group for their valuable suggestions in writing this paper.

References

Figure 1: Porosity section connecting Minagish and Umm Gudair Structure shows better porosity development over East Umm Gudair high.