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Extended Abstract

Determination of The Oil Ring in the Pushed-aside Reservoirs, Using Seismic Data and Petrophysical Logs- A case study from an oil reservoir in the south Iran

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Abstract

Usually in anticline structures where the presence of hydrocarbons has been proven, gas and oil are laterally to each other, which due to the difference in density, the gaseous layer at the top (peak) and the oil fluid at the bottom of the anticline structure. Drilling is done at the points that include the maximum height of the oil column and usually these points are at the top of the structure. However, in some special cases, and in the "Pushed-aside" oil reservoirs, it has been seen that the oil column is located in the edges of the anticline structure next to the gas layer at the top, but due to drilling on the center of this structure and the well entering the bottom layer through the gas layer, the oil in the edges of the structure remains in place without extraction. The phenomenon that oil is in the form of an oil ring (donut-shaped) and appears to have been pushed from the center to the sides by the gas cap and the thermodynamic conditions of the oil column reservoir can have a profound effect on the detection and amount of oil in the reservoir.

In this research, by using the well logs and seismic data, the remaining oil ring of Aboozar oil field and the fluids boundary of the upper horizon of the reservoir were determined by using the analysis of amplitude variation with offset. Direct modeling results can be used to plot AVO curves and detect classification of AVO anomalies. With Pre-stack inversion, using different AVO Attributes and the LMR parameters the fluid type and lithology of the upper horizon of the reservoir were identifiable. The results indicate the presence of oil in the proximity of gas in the Upper Asmari Formation, as the oil ring

1. Introduction

Usually in anticline structures where the presence of hydrocarbons has been proven, gas and oil are adjacent to each other, and due to the difference in density, the gaseous layer is at the top (peak) and the oil fluid is at the bottom of the anticline structure [1]. Drilling is done at the points that include the maximum height of the oil column and usually these points are at the top of the structure. However, in some special cases, such as in the "Pushed-aside" oil reservoirs, it has been seen that the oil column is located in the edges of the anticline structure next to the gas layer at the top, but due to drilling on the center of this structure and the well entering the bottom layer through the gas layer, the oil in the edges of the structure remains in place without extraction. The phenomenon of oil being in the form of an oil ring (donut-shaped) and appearing to have been pushed from the center to the sides by the gas cap and the thermodynamic conditions of the oil column reservoir can have a profound effect on the detection and amount of oil in the reservoir.

2.Materials and Methods

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In this research, by using the well logs and seismic data, the remaining oil ring of Aboozar oil field and the fluids boundary of the upper horizon of the reservoir are determined by using the analysis of amplitude variation with offset. Direct modeling results can be used to plot AVO curves and detect the classification of AVO anomalies. With pre-stack inversion, using different AVO attributes and the LMR parameters, the fluid type and lithology of the upper horizon of the reservoir will be identifiable [2], [3]. Quantitative methods of interpreting seismic data in the stages of exploration to the production of oil reservoirs have replaced qualitative methods, over time, and have found their place in the upstream oil industry. AVO Analysis is one of the most successful methods for exploring reservoir zones. This technique uses pre-stack seismic data to determine the hydrocarbon reservoir and can be a direct attribute of hydrocarbon in clastic rocks [4], [5]. In this research, the AVO analysis method has been performed in order to show the hydrocarbon zone in the upper horizon of the Ghar sandstone reservoir and to determine the oil ring in the Aboozar oil field in the Persian Gulf. This study uses a series of 3D pre-stack seismic data and well logs. First, forward modeling and artificial seismograms were performed by using the well logs. According to the result of forward modeling and calibration between real seismic data and well logs, the classification of AVO anomalies and AVO curves was identified. Then the advanced AVO pre-stack inversion method was first applied to the wells and finally to the real seismic data. By the obtained resistance of the acoustic compression wave, acoustic shear wave and density, the reservoir area was separated in terms of lithology and seismic resistance [6]. By using the result of pre-stack inversion, the extracted AVO attributes and the cross plot of different AVO attributes on real seismic data, the upper horizon of the Ghar sandstone reservoir was separated in terms of fluid content and lithology. All of these steps in AVO analysis are complementary, which are finally able to detect the oil ring, fluid separation and lithology of the study area.

The purpose of using these methods is to upgrade the quality of seismic signals to improve the quality of the results obtained from quantitative interpretations. In the next step, the available petrophysical information was examined and their relationship with seismic data was evaluated by calculating valid time-depth relationships [7]. During the calculation of time-depth relations, the representative seismic wavelet was extracted in the reservoir area; to be used in the process of AVO analysis and AVO inversion, Fig. 1.

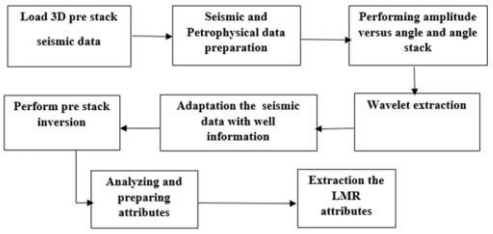

Fig. 1. Work steps in this study

Using seismic and petrophysical data of three logs in Aboozar oil field, we performed AVO analysis, applying AVO attributes, pre-stack inversion to extract the LMR parameters to determine the oil ring in the horizon lower Fars up to the Ghar reservoir horizon. After the initial preparation of the data and loading them into the software, methods for improving the quality of pre stack seismic data were used.

3. Results and Conclusions

By combining the information of compression wave, shear wave and density seismic sections, compression wave acoustic resistance, shear wave acoustic resistance and density seismic section was obtained. After obtaining the acoustic resistance sections, they were extracted on the seismic sections using AVO analysis well logs to determine the type of forming fluid and the oil ring [8]. Two and three-dimensional sections of acoustic resistance were displayed based on the model, as well as intersection diagrams of compression, shear and density waves compared to the diagrams obtained from the survey well [9]. Finally, by drawing the cross-plot of AVO attributes, the best attribute was extracted and drawn. Then, the inversion of the entire volume of data was done to extract the LMR parameters at the well site to determine the nature and confirm the accuracy of AVO analysis in detecting the fluid above the Ghar reservoir and to obtain a high correlation coefficient (89%) which is shown in

the Fig. 2.

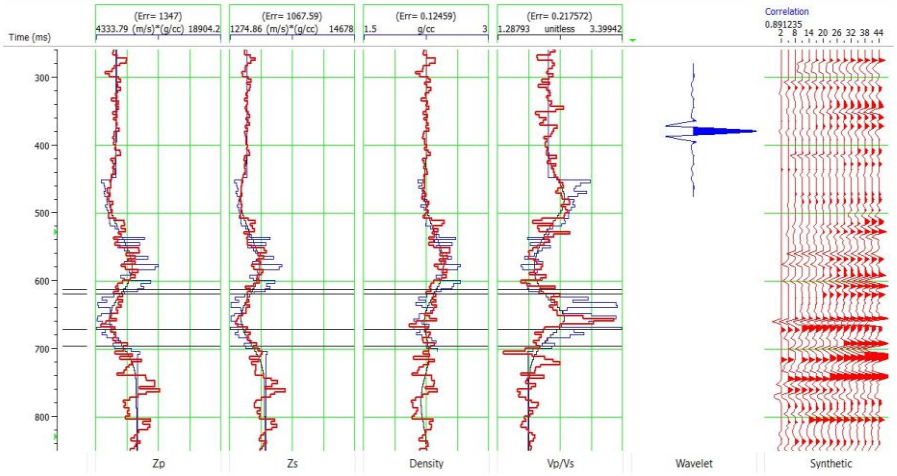

Fig. 2. Appling the pre-stack inversion on seismic data and well logs.

The results indicate the presence of oil in the proximity of gas in the upper horizon of the Ghar sandstone (upper Asmari) as an oil ring.

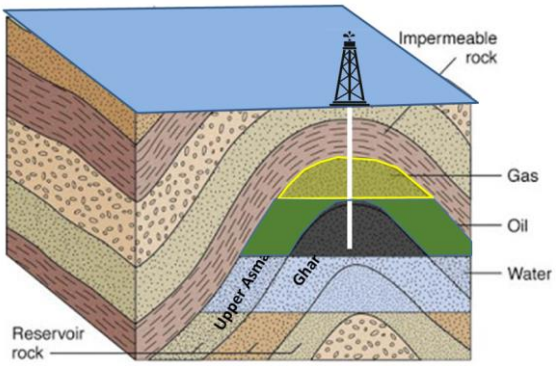

Fig. 3. Presence of Oil ring in Upper Asmari Formation and presence of gas at the crest.

Further investigation of the fluid type of the upper carbonate reservoir (the shallowest) hydrocarbon layer indicated the presence of gas in that area. To investigate the relationship between the Ghar formations and the upper carbonate reservoir after analyzing and processing the seismic data and petrophysical logs, the possible presence of oil in the reservoir showed that the upper carbonate was in the form of an oil ring with a gas cap, Fig. 3.

4. Acknowledgment

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