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Extended Abstract

The application of equivalent pore aspect ratio (EPAR) in detecting the pore types and determining rock types, Kangan and Dalan formations, Persian Gulf

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Abstract

Carbonate reservoirs are very complex and heterogeneous. Overcoming heterogeneity is important and necessary for accurate reservoir characterization. Dalan-Kangan formations, as the largest non-associated gas reservoir of the world, are heterogeneous and complex due to the influence of the sedimentary environment and diagenesis processes. Carbonate reservoirs are routinely studied using laboratory data. The use of well logging instead of using laboratory methods is very cost-effective in reducing time and cost. To overcome the heterogeneity by acoustic log, samples of Dalan-Kangan carbonate formations were prepared. A total of 87 limestone thin sections were evaluated by petrography, routine core analysis, and sonic velocity. Porosity, permeability, sedimentary textures, pore types, and diagenetic processes were determined precisely. From the studied well, well logging and acoustic logs were also available. After data quality control, the acoustic log was converted to velocity. Velocity-porosity model was constructed based on the differential effective medium (DEM) approach for different values of equivalent pore aspect ratio (EPAR). The results show that moldic, vuggy, interparticle, and microporosity pores have the largest aspect ratio, respectively. Due to their spherical shape and high aspect ratio at the given porosity, moldic and vuggy pores have higher velocity than flat and narrow pores. Through the geometrical shape and pore type and by using the acoustic log, the rock types were determined. These rock types clearly showed the porosity evolution, permeability changes and diagenetic processes that have been occurred in Dalan-Kangan reservoirs.

1. Introduction

Dalan-Kangan carbonate formations and their equivalents in Arab countries, which are known as Khuff Formation, constitute an important gas reservoirs. These formations are the largest non-associated gas reservoirs of the world [1, 2]. The ambiguous behaviors of elastic properties of carbonate rocks are influenced by the complex pore system and geometry of carbonate rocks [3, 4], which affect seismic and acoustic waves [5].

This research was carried out on the heterogeneous and complex formations of the Permian-Triassic Dalan and Kangan formations. The aim of this study is to identify the pore type and diagenesis using the acoustic log. Next, rock types were determined to manage reservoir heterogeneity using the obtained results.

2. Methodology

The collected data includes well logs, cores, and thin sections in the studied interval of Dalan and Kangan formations in the Persian Gulf. In this research, 400 meters of core was extracted from a well in the central part of the Persian Gulf. A total of 87 limestone thin sections were selected to show all textures and pore types. The analyses

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include measuring porosity and permeability, recording sedimentary textures, pore types, and diagenetic processes. Also, the acoustic log was available from the studied well. The acoustic log data were converted to velocity according to equation (1).

$$V = 304.8/DT\ (km/s) \quad (1)$$

DEM approach was used to construct velocity-porosity curves for different values of equivalent pore aspect ratio (EPAR) and then such curves were compared with velocity-porosity data obtained from this study.

3. Results and Conclusions

Fig.1 shows the results of DEM modeling for different values of EPAR. The data (87 limestone thin sections) are labeled according to the dominant pore type. Moldic pores have the highest Vp-EPAR, on average. Vuggy, interparticle, and microporosity are located after moldic pores, respectively.

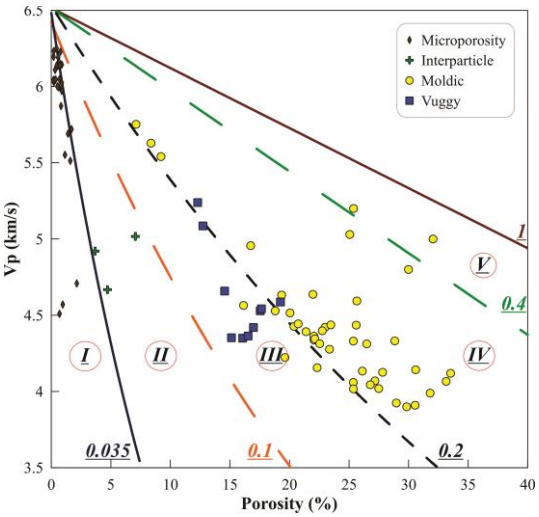

Fig. 1. The drawn curves are the results of DEM modeling for different values of EPAR.

Moldic pores are often located in rock types 4 and 5. vuggy pores are more abundant in rock type 3. Interparticle and microporosity are present in rock types 1 and 2. The frequency of microporosity is higher in rock type 1 (Fig.1).

Spherical pores are stiffer than flat and crack-like pores [6, 7]. Due to their geometrical shape, moldic and vuggy pores have a higher acoustic velocity than others that have a flat and narrow geometrical shape at a given porosity.

Using the drawn curves, the rock types were determined, which well divided the reservoir into separate units. The quality of the reservoir can be predicted using these rock types (Table.1).

The pore aspect ratio was also used to identify diagenetic processes. Diagenetic processes change the pore type and pore structure [4]. For this reason, this method can be used to detect diagenetic processes in carbonate reservoirs.

Table 1. The average of porosity and permeability of rock types.

Rock type	*Porosity (%)*	*Permeability (mD)*	*Sample*
1	*0.71*	*0.01*	*22*
2	*2.12*	*0.72*	*10*
3	*17.65*	*53.94*	*13*
4	*23.61*	*4.49*	*40*
5	*28.72*	*2.56*	*2*

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