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Extended Abstract

Investigation of the effect of sedimentary and diagenetic processes on the pore-throat sizes, Dalan and Kangan formations in the central part of the Persian Gulf

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Abstract

This study investigated the effect of various factors on the pore-throats, in a well in the upper Dalan and Kangan Formations in the central part of the Persian Gulf. Microfacies, sedimentary environments, dominant diagenetic processes on microfacies and the general effect of primary and secondary processes on the dispersion of porosity and permeability data, was investigated. Petrographic studies led to the identification of 12 microfacies in four facies belts in an epeiric carbonate platform environment. The grain dominant texture has higher values of porosity and permeability compared to the mud dominated texture. The most prevalent diagenetic processes are dolomitization, dissolution, cementation and compaction. The moldic, vuggy, intercrystalline and intergranular porosities are the most important identified pores. The study of the effects of each diagenetic process separately indicates the effect of the process of dissolution and dolomitization on increased the pore-throats and reservoir quality. Results showed that cementation and compaction alone do not have a reducing role and its greater effect is due to the combination of both factors. In order to investigate the effects of facies and diagenesis on the pore-throat, porosity and permeability data were plotted on the Winland diagram and seven rock types with different pore-throats were identified. Due to the effects of different diagenetic factors on the microfacies, the pore-throat sizes vary between same microfacies. The grain dominant facies (packstone and grainstone) belonging to the shoal facies belt, have the highest pore-throats and the best rock type determined by the Winland method. Plotting the porosity and permeability data in the Winland diagram has let to detection of 7 zones with different pore throat size, that samples with higher R35 are affected by dissolution and dolomitization and samples with lower R35 are affected by cementation and compaction.

1. Introduction

The Dalan Formation of Permian age and the Kangan Formation of Triassic age are recognized as the largest gas reservoirs in the Persian Gulf. These carbonate reservoirs exhibit high reservoir heterogeneity in terms of reservoir properties, making modeling of these reservoirs challenging [1]. Porosity and permeability are among the petrophysical properties of reservoirs that are of great importance in assessing production potential and reserves. The reservoir quality of carbonate reservoirs is primarily influenced by depositional characteristics (microfacies) initially and post-depositional processes (diagenesis and fracturing) secondarily [2, 3]. The combination of these influences ultimately leads to the formation of pore systems and their geometry in reservoirs, which in turn control the petrophysical properties of the rock [4].

The Dalan and Kangan formations are primarily

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influenced by diagenetic processes such as dissolution, cementation, and dolomitization. Therefore, reservoir quality is largely influenced by diagenetic processes. These processes alter the pore throat diameter. Although primary microfacies also play a major role in the formation of porous and dense zones. Determining lithofacies from a geological perspective involves identifying units that are placed in similar conditions in terms of depositional characteristics (lithology, sedimentary texture, fossil content, and diagenesis) [10, 11]. From an engineering perspective, lithofacies are applied to a part of the reservoir that has similar petrophysical properties such as porosity and permeability. This study, after examining the results of facies studies, diagenesis, and factors affecting reservoir quality (both primary and secondary), will clarify the impact of these two factors on pore throat diameter in the upper Kangan and Dalan formations.

2. Methodology

In this study, sedimentological and petrophysical data from a well in a field located in the central part of the Persian Gulf were utilized. A total of 1570 thin sections were prepared from the core (482 thin sections related to the Kangan Formation and 1088 thin sections from the Dalan Formation) for analysis 1/3 of each thin sction was painted with red-alizarin for distinguish calcite and dolomite. Some of the thin sections were color-coded to distinguish between lithologies (calcite from dolomite). The naming and description of carbonate rocks were done based on the methods of Dunham [28]. and Embry & Klovan [29], and the analysis of microfacies and depositional environment was carried out using the Flugel method [30]. Besides identifying primary microfacies, diagenetic features were also identified base on visual estimation method.

The influence of primary factors (lithology, sedimentary characteristics) and secondary factors (diagenesis) on porosity and permeability data was separately analyzed by plotting porosity-permeability diagrams for each parameter. Furthermore, Winland plots were used along with 1440 porosity and permeability data points to investigate and understand the impact of microfacies and diagenetic processes on pore throat diameter. In this regard, porosity and permeability data corresponding to each microfacies were plotted on the Winland petrophysical diagram to examine the distribution of microfacies and the influence of primary processes on these lithofacies.

3. Results and Conclusions

The studied formations exhibit significant heterogeneity, with various factors contributing to their heterogeneity. Petrographic studies have shown that the studied sequence is composed of 12 microfacies corresponding to 4 microfacies belts. Dolomitization, dissolution, cementation, and compaction are among the most dominant diagenetic processes that have influenced the studied formations. The plotting of porosity and permeability data on the Winland diagram resulted in the division of the formations into seven zones with different pore throat diameters.

Different sedimentary and diagenetic factors have influenced the pore throat diameter, leading to changes in the position of each microfacies on the Winland diagram. In general, dissolution, dolomitization, tensional fractures with cementation lead to an increase in pore throat diameter, shifting the samples to zones with higher R35 values (R35>10 and 5<R35<10). On the other hand, cementation and compaction result in a reduction in pore throat diameter, causing the samples to move to zones with lower R35 values (0.5<R35<1, 0.1<R35<0.5, and R35<0.1).

4. References

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