Identification and estimation of grain size from wire-line logs and its effect on reservoir character-A case study in Hazad sands of Gandhar field.

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Summary

The quality of a reservoir is defined by its hydrocarbon storage capacity and deliverability. Grain size distribution is one of key sedimentological characteristics used to analyse the reservoir character and plays a major role in hydrocarbon storage capacity and deliverability. Traditionally, grain size are identified and computed from cores. However, while core data provide direct computations of grain size, they are costly to acquire and recovery is often less than 100% as they seldom encompass the entire stratigraphic interval of interest. Wireline logs can provide an effective and reliable means to identify and estimate the grain size and thus study the reservoir character.

The present study is carried out in Hazad member of Gandhar field of Cambay Basin where low resistivity hydrocarbon bearing reservoirs are known to occur in some areas. Producibility of reservoirs also suffers. In the present study identification and estimation of grain size has been carried out through wire-line logs. Detailed analysis of conventional as well as NMR logs has been carried out to study the grain size and the reservoir character. NMR and porosity logs have proved to be very useful in in the identification and estimation of grain size and in the overall study of the reservoir.

Analysis of Porosity and Permeability X-Plots have shown that grain size is small .NMR log has given good estimation of grain size which is comparable to silt. The study has also shown that because of smaller grain size irreducible water saturation increases which lowers the resistivity of the hydrocarbon bearing reservoirs. It also lowers the permeability.

The present study shows that that grain size has a major role to play in characterizing such type of reservoirs and Wireline logs can provide a cost effective and reliable means to identify and estimate the grain size and thus study the reservoir character.

Introduction

The Gandhar Field was discovered in 1983 and production began in 1986. The main hydrocarbon reservoirs of Gandhar Field are in the Hazad Member, which contains twelve sandstone units separated by intra formational shales. The top most GS-12 sand unit of Hazad member is one of the main producing sands and has low resistivity in some parts of the field. The producibility also suffers. To study such behaviour, characterizing the reservoirs become imperative. The hydrocarbon storage capacity is characterized by the effective porosity and the size of the reservoir, whereas the deliverability is a function of the permeability. Effective porosity is the volume percentage of interconnected pores in a rock. The remaining space in the rock is occupied by the framework or matrix of the rock and, if present, non-connected pore space.

Traditionally, grain size are identified and computed from cores. However, while core data provide direct computations of grain size, they are costly to acquire and recovery is often less than 100% as they seldom encompass the entire stratigraphic interval of interest. Wireline logs can provide an effective and reliable means to identify and estimate the grain size and thus study the reservoir character. This is the objective of the present study.

Methodology

In order to identify and estimate the grain size and to understand the reservoir character of low resistivity GS-12 sand unit of Hazad Member of Gandhar area a detailed analysis through open hole conventional and

NMR Wireline logs were carried out. The output results were studied and validated with the available core studies.

Discussion

The present study is carried out in GS-12 unit of Hazad member of Gandhar field of Cambay Basin where low resistivity hydrocarbon bearing reservoirs are known to occur in some areas. Producibility of reservoirs also suffers. In the present study identification and estimation of grain size has been carried out through wire-line logs. Detailed analysis of conventional as well as NMR logs has been carried out to study the grain size and the reservoir character. Grain size has direct bearing on the reservoir character. Small grain size can lower resistivity values over an interval despite uniform mineralogy and little or no clay content. The increased surface area associated with finer grains holds more irreducible water and this increases the irreducible water saturation thus lowering the resistivity of the reservoir depending upon the water salinity. In order to get an idea about the grain size and its effect in lowering the resistivity, detailed grain size study of low resistivity GS-12 reservoir sands of Gandhar area was carried out through the analysis of the available open hole conventional and NMR log data.

NMR log analysis was carried out for GS-12 unit of Hazad member wells. The capillary pressure of a reservoir affects the magnitude and distribution of water saturation and thus the hydrocarbon volume in a given reservoir area. In a reservoir, zones with larger pores and pore throats have lower capillary pressure, lower irreducible water saturation, and higher hydrocarbon pore volume.

The T2 log distribution curve indicates that most of the signal comes from micro pores and capillary bound fluid (3ms- 33ms) which corresponds to irreducible water and less signal is from free fluid (greater than 33ms) (Plates: 1 &2). This shows the dominance of fine grains in low resistivity GS-12 sands leading to formation of capillaries which hold more irreducible water. From the NMR logs of these wells, pore size and grain size plots were also generated. These plots have shown that grain size in these wells varies between 17-38 microns (Plates: 1 &2). This confirms that the grain size is small and corresponds to silt.

Studies carried out on cores of GS-12 unit in clean reservoir sands have shown that they are made up of fine to medium coarse Quartz arenite to Quartz wacke. They have also shown that reservoir sands are made up of mostly fine to texturally immature Quartz wacke with abundant clay matrix.

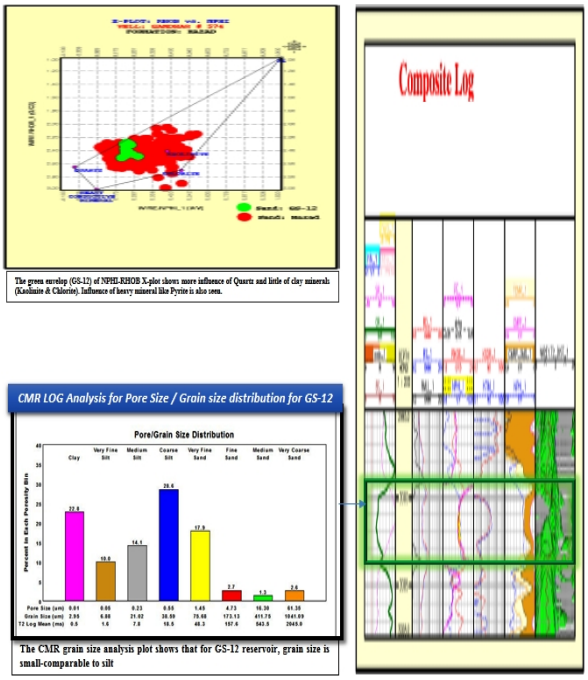

Plate: 1. Integrated analysis of conventional and NMR logs for estimation of grain size and study of reservoir character

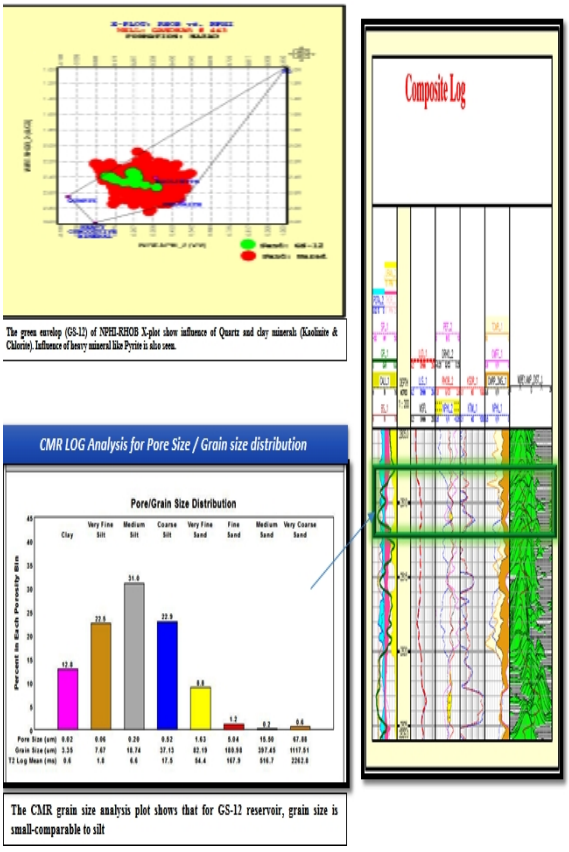

Plate: 2. Integrated analysis of conventional and NMR logs for estimation of grain size and study of reservoir character

Analysis of X-plot of log derived porosity and corresponding permeability in low resistivity GS-12 sand unit of Gandhar wells (Plate: 3) shows that with increase in porosity there is little variation in permeability which is also too low. Porosity is theoretically independent of grain size; however, permeability varies in direct proportion to the grain size. Low permeability in spite of increase in porosity indicates influence of smaller grain size. As discussed above, large part of the porosity is due to micro porosity and capillary porosity. Therefore in such cases the permeability is low and despite of increase in porosity the permeability is still low and does not show much variation.

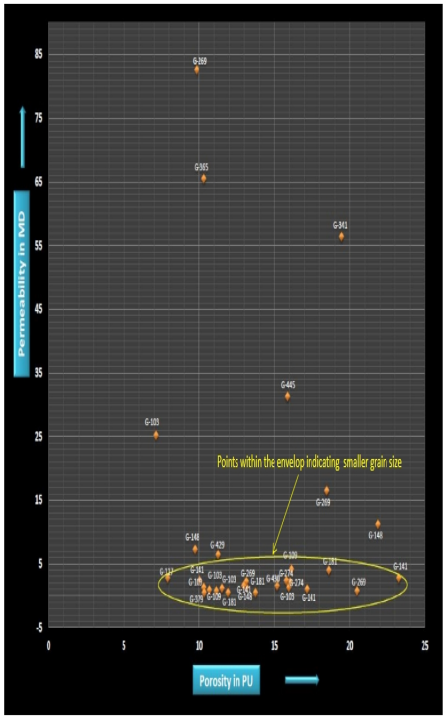

Plate: 3. Analysis of X-plot of log derived porosity and corresponding permeability for grain size.

Core results validates the log results and shows that grain size of GS-12 sand unit in low resistivity wells are small, comparable to silt size.

The study of conventional open hole and NMR log analysis establishes the dominant presence of small and fine nature of grains in the low resistivity GS-12 unit of Gandhar area. This is seen for little or clay free low resistivity GS-12 reservoirs. The smaller grain size has more micro pores and capillaries which hold more irreducible water and leads to high water saturation and lowering of resistivity.

CONCLUSIONS

The present work has led to a better understanding of the reservoir character through Wireline logs. The study has brought out the importance of conventional open hole logs and NMR log in identification and estimation of grain size and thus study of the reservoir character. NMR analysis has proved to be of immense value for quantifying pore size distribution, micro porosity, capillary bound porosity, irreducible water and typing of fluid. The present study shows that that grain size has a major role to play in characterizing a reservoir and wireline logs can provide a cost effective and reliable means to identify and estimate the grain size and thus study the reservoir character.

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