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The Distribution of Cementation and Dissolution Processes in Relation to Sedimentary Facies and Disconformity Surfaces of the Sarvak Formation in One of Hydrocarbon Fields in Southwest of Iran

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Abstract

This study has been focused on the relationship between cementation and dissolution processes with depositional facies and unconformity surfaces of upper part of the Sarvak Formation (Cenomanian-Turonian and mid-Turonian unconformity surfaces), using core and thin section data from a key well. Based on petrographic studies, six facies related to lagoon, slope and open marine sub-environments were identified. The results of this study indicate that the dissolution and cementation processes have been occurred in several diagenetic stages. Dissolution of unstable skeletal grains under the effect of eogenetic diagenesis created extensive vuggy porosity. In addition, during the telogenetic diagenesis and in relation to unconformity surfaces, vuggy pore types within the grains and rock matrix have been developed. The distribution of calcite cement within the reservoir shows a close relationship with initial mineralogy of the skeletal grains, size of dissolution vugs as well as density and the width of the factures. Calcite cement occurs as drusy and blocky forms and with meteoric and burial source within the dissolution vugs and microfractues. Within the Turonian interval that has been situated below the mid-Turonian unconformity, due to the mud-dominated nature of lagoon and open marine facies, dissolution and cementation have insignificant distribution, and calcite cement is mostly observed in relation to fractures. In contrast, in the interval below the Cenomanian-Turonian boundary, these processes have more distribution due to the frequency of grain-dominated facies. The results of this study show that the nature of depositional facies has a significant role on distribution of cementation and dissolution processes within the Sarvak Formation.

Keywords: : Sarvak Formation, Sedimentary Facies, Disconformity, Cementation, Dissolution.

Introduction

In carbonate reservoirs, disconformity surfaces (also known as palaeo-exposure surfaces) can be examined in different aspects including orders and types, duration of the hiatus, their effects on reservoir properties and impacts on diagenetic patterns [1,2,3,4,5,6]. These surfaces are common geologic features in the Cretaceous sedimentary record of the Middle East. In Sarvak Formation of the Abadan Plain, four main disconformity surfaces have been differentiated that can be considered as sequence boundaries [5]. Among these surfaces, the mid-Turonian and Cenomanian-Turonian boundary disconformities have exerted a significant control on reservoir properties of the upper Sarvak Formation of the Abadan Plain. This study aims to focus on the distribution of cementation and dissolution in relation to sedimentary facies and disconformity surfaces of the Sarvak Formation.

In Abadan Plain, the structures produce oil mainly from the upper Khami (Fahliyan and Gadvan formations) and Bangestan (Sarvak and Ilam formations) groups. The Sarvak Formation is stratigraphic equivalent of the Mauddud, Ahmadi, Rumaila and Mishrif formations of the Mesopotamian Basin [5]. The upper part of the Sarvak Formation (i.e. Mishrif equivalent) with a thickness of about 300¬m, constitutes the main reservoir interval in the Abadan Plain. Two important disconformity surfaces have influenced the Cenomanian-Turonian intervals of the Sarvak Formation in the Abadan Plain. Thin section and core photomicrographs from these surface shown in figure 1.

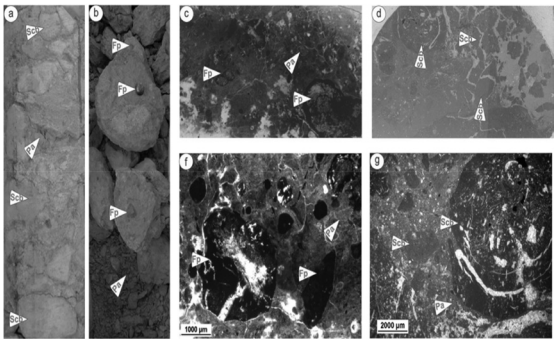

Fig 1. Core slabs (a-b) thin sections (f-g), and scans (c-d) displaying diagenetic features related to the Cenomanian-Turonian (a-d-g) and mid-Turonian (b-c-f) disconformities of the Sarvak Formation.

Methodology

In this study, macroscopic description of about 85 m of drilled cores and petrographic study of 310 thin sections have been carried out in a key wells selected from oil field located in the Abadan Plain. Prepared thin sections were stained partially with Alizarin Red-S for differentiation of calcite from dolomite. For better determination of sedimentary properties and diagenetic features, all thin sections were scanned by CREO-IQSMART3 in petrography laboratory of RIPI. Achieved results from core description and petrographic studies are used in order to identify facies characteristics and diagenetic features related to the disconformity surfaces.

Results and discussion

In the Abadan Plain area, located in NE margin of the Arabian plate, three main disconformity surfaces confine the two third-order sequences of the upper Sarvak Formation. These surfaces have been dated based on biostratigraphic analysis as mid-Cenomanian (Disc-1), Cenomanian-Turonian (Disc-2) and mid-Turonian (Disc-3) (Assadi et al., 2016). Due to the effects of the Disc-2 and Disc-3 on main reservoir intervals of the formation and available information, present study only concentrated on the sedimentary and diagenetic

evidences related to these surfaces.

Based on petrographic studies, six facies related to lagoon, slope and open marine sub-environments were identified (Fig.2). The results indicate that the dissolution and cementation processes have been occurred in several diagenetic stages. Dissolution of unstable skeletal grains under the effect of eogenetic diagenesis created extensive vuggy porosity. In addition, during the telogenetic diagenesis and in relation to disconformity surfaces, vuggy pore types within the grains and rock matrix have been developed. Distribution of calcite t cement within the reservoir shows a close relationship with initial mineralogy of the skeletal grains, size of dissolution vugs as well as facture characteristics. Calcite cement occurs as drusy and blocky forms and with meteoric and burial source within the dissolution vugs and microfractues. Within the Turonian interval that has been situated below the mid-Turonian disconformity, due to the mud-dominated nature of lagoon and open marine facies, dissolution and cementation have insignificant distribution, and calcite cement is mostly observed in relation to fractures. In contrast, in the interval below the Cenomanian-Turonian boundary, these processes have more influenced due to the frequency of grain-dominated facies. The results show that the nature of depositional facies has significant role on distribution of cementation and dissolution processes within the Sarvak Formation. Distribution of these features is in close accordance with nature of the primary depositional facies.

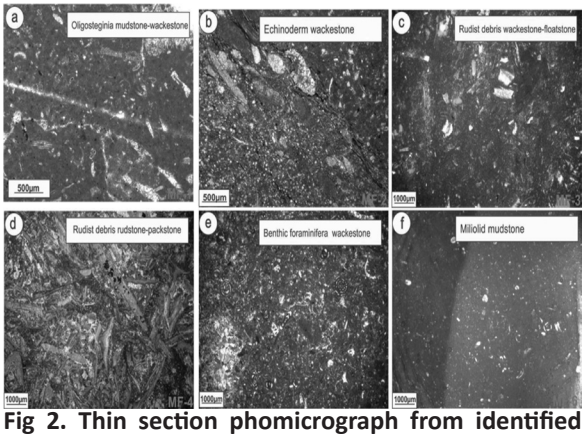

Fig 2. Thin section phomicrograph from identified facies across the disconformity surfaces.

In mud-dominated facies, recrystallization of micrite, chemical compaction and bioturbation were the main diagenetic features. In this facies, cementation is commonly confined to fractures with sparse occurrence of dissolution vugs within the matrix. In contrast, the grain-dominated facies were much more influenced by cementation, and dissolution induced by meteoric diagenesis related to the disconformities (Fig. 3).

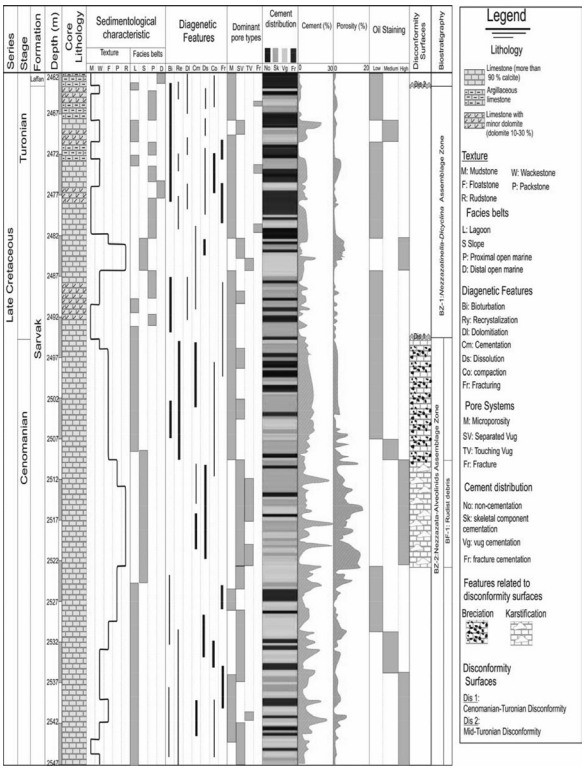

Fig.3: Distribution of facies/diagenesis characteristics, pore system and reservoir properties across the Cenomanian-Turonian and mid-Turonian disconformities.

In addition, in the studied intervals, primary facies have the main control on distribution of pore types in the reservoir. In grain-supported facies of rudist debris, solution interparticle and vuggy porosity were dominant, while the mud-supported facies related to lagoon and open marine settings were mainly being characterized by microporosity and some vuggy porosity.

From the reservoir characterization point of view, this disconformity in most of the studied wells is concordant with the creation of the reservoir intervals in oil fields of the Abadan Plain. In these wells, dissolution resulted from the meteoric diagenesis is confined to grain-dominated facies such as rudist debris observed below this surface.

Dissolution and cementation mostly related to the major palaeo-exposure surfaces (Cenomanian-Turonian and mid-Turonian disconformity) are the main diagenetic processes which significantly directed the pore system properties within the reservoir. The distribution of these diagenetic processes shows close relationship with the grain or mud dominated nature of facies below the disconformity surfaces. As the impact of cementation and dissolution is mainly confined to shoal, rudist-biostrome and rudist debris facies. In contrast, the mud dominated lagoon and open marine facies below the mid-Turonian disconformity have been insignificantly influenced by the cementation and dissolution processes.

Conclusion

The integration of the results from core description and petrographic studies in an oil field of the Abadan plain resulted in new finding about the distribution of cementation and dissolution in relation to sedimentary facies and disconformity surfaces of the upper Sarvak Formation as follows:

1. The Cenomanian-Turonian disconformity formed as a result of local tectonic uplift and movement of basement blocks and salts diapirism, while the mid-Turonian disconformity is shaped by the effect of sea level fall and tectonic activity in relation to the Neo-Tethys Ocean closing.
2. Facies variations in relation to the disconformity surfaces of the upper Sarvak Formation, resulted in the recognition of six microfacies representing a shelf carbonate platform.
3. Dissolution and cementation mostly related to the major palaeo-exposure surfaces (Cenomanian-Turonian and mid-Turonian disconformity) are the main diagenetic processes which significantly directed the pore system properties within the reservoir. The distribution of these diagenetic processes shows close relationship with the grain or mud dominated nature of facies below the disconformity surfaces. As the impact of cementation and dissolution is mainly confined to shoal, rudist-biostrome and rudist debris facies. In contrast, the mud dominated lagoon and open marine facies below the mid-Turonian disconformity have been insignificantly influenced by the cementation and dissolution processes.
4. Microporosity and vuggy pore spaces as two dominant pore types within the reservoir are related to mud-dominated facies and the dissolution originated from effect of extensive meteoric diagenesis in most grain-dominated facies respectively.

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