Introduction

When studying the Upper Cretaceous carbonate strata of Middle East, geologists observed a kind of geobody that resembles channels, for example, channelized system of Natih formation in Oman. On the origin of this kind of channels, the opinions are different. Based on the the stratigraphic context and sediment fill, it can be divided into incision and tidal channels (Grelaud C., Razin P. & Homewood P., 2010). At the sedimentary study of Sarvak formation, tidal channels were discovered. Based on the sedimentary environment of Sarvak formation, the characteristics of the places where the tidal channels developed and the sediment fill were discussed.

Method and/or Theory

The core and seismic data is the base of study. The geological setting of tidal channels can be identified by applying carbonate sedimentary principles and combined analysis of seismic facies and seismic attributes analysis. The sedimentary characteristics of tidal channels were discussed afterwards.

Example

1. Background

Azadegan oilfield located in southwest of Iran. Sarvak formation is the most important reservoir in Azadegan oilfiled.

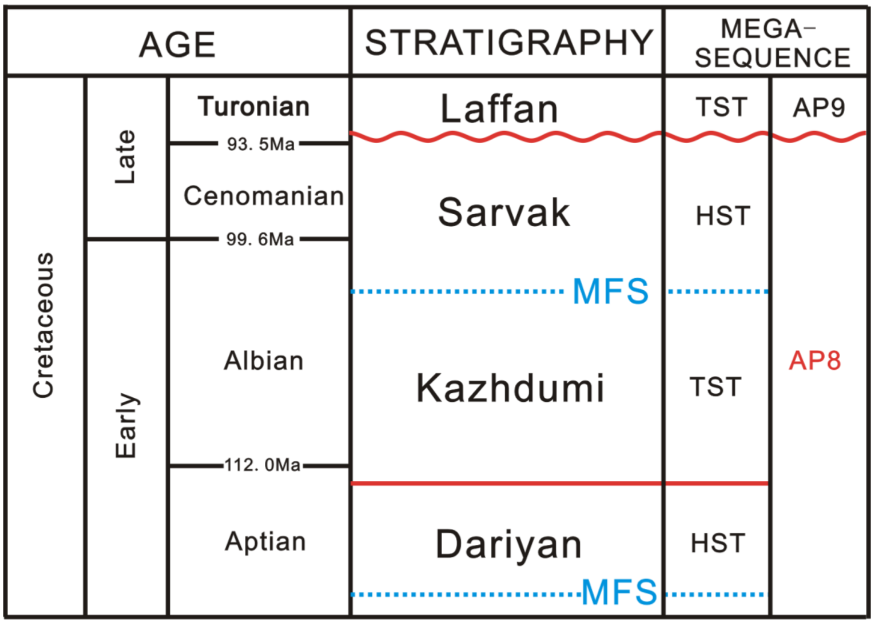


Figure 1 *Stratigraphy and megasequence of Sarvak formation (TST – transgressive system tract; HST – high-stand system tract; MFS – maximum flooding surface)*

Sarvak formation is a carbonate serial developed in Cenomanian of Later Cretaceous, underlying Kazhdumi limestone formation and overlying Laffan shale formation (Figure 1). The outcrop located in Khuzestan Province of Iran indicates that the total thickness of Sarvak formation reaches 832m, divided into three units upward, as the bottom unit 1 is a 255m thickness dark-gray bedded argillaceous limestone with dark thin mudstone interbed, showing impressions of ammonites; middle unit 2 is a 535m thickness massive grown limestone containing rudist fragments, showing large cross bedding; top unit 3 is a 42m thickness layering limestone and brecciola (Alsharhan A.S. & Nairn A.E.M., 1997). Based on the previous study, Sarvak formation belongs to the high-stand system tract of tectonic megasequence AP8 of Middle East area, whose top is a regional unconformity (Peter R.S., Raymond A., David M.C. *et al.*, 2001). The depositional environment changes from continental shelf upward to shallow platform to exposure weathering, representing a classic shallowing upward carbonate depositional serial.

2. Lithology

The thickness of Sarvak formation in Azadegan oilfield is around 700m, divided into 13 layers from Sar-1 to Sar-12 and Sar-Intra downwards. Since the oil-water contacts are usually in Sar-8, the study of Sarvak formation was mostly concentrated from Sar-1 to Sar-8.

According to core data, the lithology of each layer of Sarvak formation was given a simple description. Upward, Sar-8 is gray massive grainstone; Sar-7 is a gray tight massive wackestone/mudstone with algal mat; Sar-4 to Sar-6 is gray or light brown-gray packstone/wackestone with apparent bioturbation; Sar-3 is brown or dark brown massive grainstone; Sar-2 is gray tight massive wackestone/mudstone that developed algal mat and interbedded with brecciola; Sar-1 is dark-gray tight massive wackestone/mudstone with abundant algal mat (Figure 2). Rudist fragments is the main component of the grain in limestone.

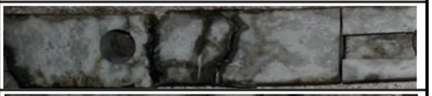
Well ID	Depth	Zone	Photo of core
Well 1	2776.07 - 2776.57	Sar-1	
Well 1	2786.50 - 2787.00	Sar-2	
Well 1	2796.12 - 2796.62	Sar-3	
Well 1	2813.50 - 2814.00	Sar-4	
Well 1	2847.86 - 2848.36	Sar-5	
Well 1	2875.50 - 2876.00	Sar-6	
Well 1	2914.00 - 2914.50	Sar-7	
Well 1	2934.00 - 2934.50	Sar-8	

Figure 2 *Photo of core in Sarvak Formation*

3. Sedimentary facies

Based on the study of core and thin sections, Sar-8 and Sar-3 developed in high energy deposition environment; Sar-4 to Sar-6 developed in relative mid-high energy deposition environment with frequent bio-activities; Sar-1 and Sar-2 developed in low energy deposition environment. According to the previous study and the characteristics of the abundant rudist reef that developed in Cenomanian of the Middle East area, the Sarvak formation limestone deposition comply with the rimmed shelf platform deposition model. Comparing with the conventional rimmed shelf platform deposition model, this kind of platform developed tidal channels on its main area (Figure 3). These tidal channels belong to a constructive/depositional system (Grelaud C., Razin P. & Homewood P., 2010). Overall, for Azadagan oilfield Sar-3 and Sar-8 belong to platform margin shallow shoal facies deposition; Sar-4 to Sar-6 belong to unrestricted platform facies deposition; Sar-2 and Sar-7 belong to restricted platform facies deposition.

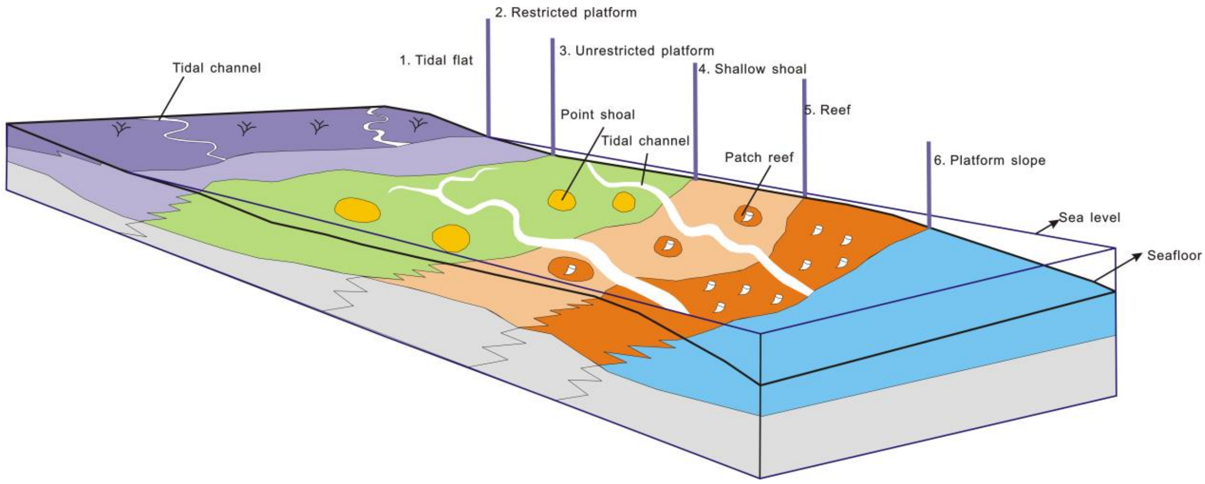


Figure 3 *Sedimentary facies model of Sarvak formation*

4. Characteristics of channels

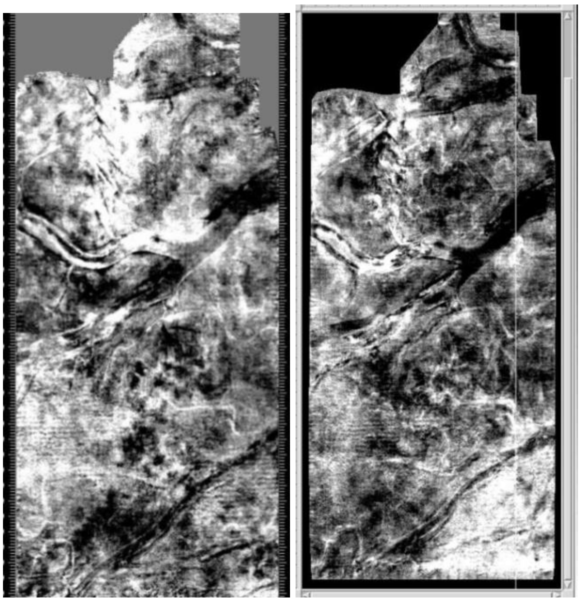


Figure 4 *Seismic time slice (Left: horizon slice; Right: strata slice)*

From the time slices scanning of the conventional 3D seismic data, geobodies that resemble channels in Sar-4 to Sar-6 can be recognized (Figure 4), this kind of channels is the tidal channel mentioned above, which is developed on the main area of the carbonate platform. On the seismic profile, the events have an apparent incised phenomenon (Figure 5), and have multi-periods.

In common sense, tidal channels were mainly developed on tidal flat; this is the result of erosion of tidal action to the coastal area. The shape of channels resembles that of rivers, and channels extend from coastal to inner land until they disappear. Study has showed that the channels in this area didn't develop in the tidal flat environment, but on the platform, including platform edge reefs, shallow shoals and open platform.

Regardless of whether it's clastic deposition or carbonate deposition, the hydrodynamic condition on tidal flat decrease from subtidal zone to supratidal zone; and channel is the path of currents with most hydrodynamic and bidirectional flow, therefore the sediment is most coarse with cross bedding. Due to the features of marine hydrodynamic, the channels that developed on the platform have resembling characteristics, which is the hydrodynamic energy is stronger than surrounding areas, and sediments within channels are coarser and cross bedding is developed.

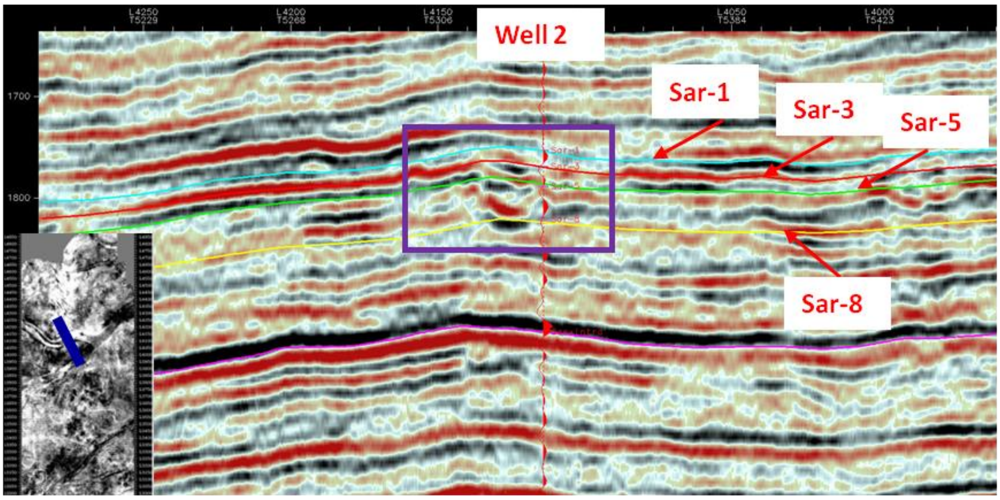


Figure 5 *Seismic profile (in the purple polygon showing the tidal channel through Well 2)*

Figure 6 *Core photo in Sar-5 of Well 2*

After the observation of core in the channel (Figure 6), the above deduction is proven. In the same layer, for instance Sar-5, outside the tidal channels developed bio-disturbed open platform wackestone/packstone, however in the tidal channels developed cross-bedded grainstone, this resembles the sediment of platform margin shallow shoal, indicating that the hydrodynamic energy in the channel is higher.

For the reasons of differences of the hydrodynamic conditions, the characteristics of tidal channels is more apparent on the relative low energy open platform. Reservoir developed in tidal channels is better than outside the tidal channels, which has been proved by core data and well production data.

By deduction, because of the decreasing of the tidal energy resulted from the increasing distance, the chances of channels that extend to restricted platform is low.

Conclusions

For limestone reservoir, normally the grainstone, developed in the environment with high hydrodynamic energy, have good physical properties Based on the study, the tidal channels that developed in the platform is resulted from high energy conditions. Therefore the tidal channels are the areas with favorable reservoirs, playing an important role in oil&gas exploration.

Reference

Alsharhan A.S. & Nairn A.E.M. 1997. Sedimentary Basins and Petroleum Geology of the Middle East. Elseviber. 1-843

Grelaud C., Razin P. & Homewood P. 2010. Channelized systems in an inner carbonate platform setting: differentiation between incisions and tidal channels (Natih Formation, Late Cretaceous, Oman). *In: van Buchem, F.S.P., Gerdes, K.D. & Esteban, M. (eds) Mesozoic and Cenozoic Carbonate Systems of the Mediterranean and the Middle East: Stratigraphic and Diagenetic Reference Models.* Geological Society, London, Special Publications, 329, 163–186.

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