Islamic Azad University
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Upper Cretaceous Petroleum System of Northwestern Persian Gulf

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Abstract

Three well - known source rocks of the Zagros basin and the Persian Gulf are Mesozoic in age.The Jurassic Sargelu, Albian Kazhdumi and Neocomian-Coniacian Garau formations have charged the Cretaceous reservoirs of this area. The northwest part of the Persian Gulf is strongly influenced by two major N-S trending paleohighs (Hendijan- Bahregansar-Regesafid-Izeh and Kharge-Mish) and surrounding plaeotroughs that play the most important role in the reservoir and source rock development. The most important reservoirs are the Cenomanian- Turonian Sarvak and Santonian Ilam formations which locally separated by a thin shaly unit of the Coniacion Laffan Formation. The reservoir facies are dominated by benthic and rudist debris on the paleohighs which laterally grading down to the basinal Cenomanian Ahmadi and Santonian Gurpi pelagic marls. In order to study the petroleum system of the northwest Persian Gulf, several 2D seismic lines and six wells were interpreted. Based on the interpreted seismic profiles the best locations for the reservoir facies could be within the pinch-out geometries around the plaeohighs which occasionally sealed by the baisn-type Campanian- Maastrichtian Gurpi marls at the top, Laffan shale at the middle and Albian Kazhdumi shale at the base as stratigraphic traps. A large hiatus exists between the top of the Cenomanian Sarvak Formation and Eocene Pabdeh Formation in the Tangue and Rage- Safid paleohighs, where these facies change could form stratigraphic traps. Toward the Nowrooz, Bahregansar Hendijan, structures, this hiatus is much shorter where Campanian- Maastrichtian Gurpi Formation directly has coverd the Sarvak Formation.

Keywords: *Petroleum System, Upper Cretaceous, Ilam and Sarvak Formations, Pinch–out, Stratigraphic trap*

1. Introduction

The studied area is located in northwestern portionof thePersian Gulf (Fig 1). Because most of the easy oils (structural traps) in the Persian Gulf have already been discovered, the recognition of stratighraphic traps is very important. For this reason, the hydrocarbon potential of the stratigraphic traps in the Zagros Provinces has gained much attention during the last few years. Hydrocarbon exploration in stratighraphic traps requires high resolution maps showing the stratal geometries and facies distribution patterns using seismic profiles calibrated from surface and subsurface data. From a hyrocarbon system point of view, the Neocomian Garau and Albian Kazhdumi shale and marls are well known source rocks (Bordenave and Hegre 2005; Bordenave and Hegre 2010), while the shallow water carbonates of the Sarvak and Ilam formations formed as reservoir rocks. These units could potentially be sealed by the Campanian / Maastrichtian Gurpi and Paleocene-Eocene Pabdeh formations at the top and Kazhdumi and Laffan formations at the middle and base. The basic stratigraphic study of the Mesozoic and Cenozoic Zagros basin were carried out by James and Wynd (1965); Kheradpir (1975); Khalili (1976); Rahaghi (1976); Setudehnia (1978) and Szabo and Kheradpir (1978). The foraminiferal-based biozonation introduced by Wynd (1965) is still the best reference for the Mesozoic and Cenozoic successions of the Zagros basin.

The tectonostratigrahic and seismo- tectonostratigrahic dataTectono- stratigraphy of the Kuh-e Mish paleohigh (South Dezful) and Kuh-e Bangestan/ Kuh-e Safid paleohighs as well as paleogeography, structural history and prospects of the Khuzestan province carried out by Hart and Setudehnia (1969); Hart (1970) also subdivided the attributed paleo-highs to three prioeds of geological times; Albian- Cenomanian, during the middle Cretaceous and the Late Cretaceous - Quaternary tectonic phases (e.g. Bangestan high). A Cretaceous regional high resolution sequence stratigraphic study was performed by Van Buchem et al. (2010). Farzadi (2006) and Ashrafzadeh (1999), studied this area based on the tectonostratigrahic and seismo- tectonostratigrahic data. Soleimany and Sàbat (2010) studied the folding systems in NW of Persian Gulf.

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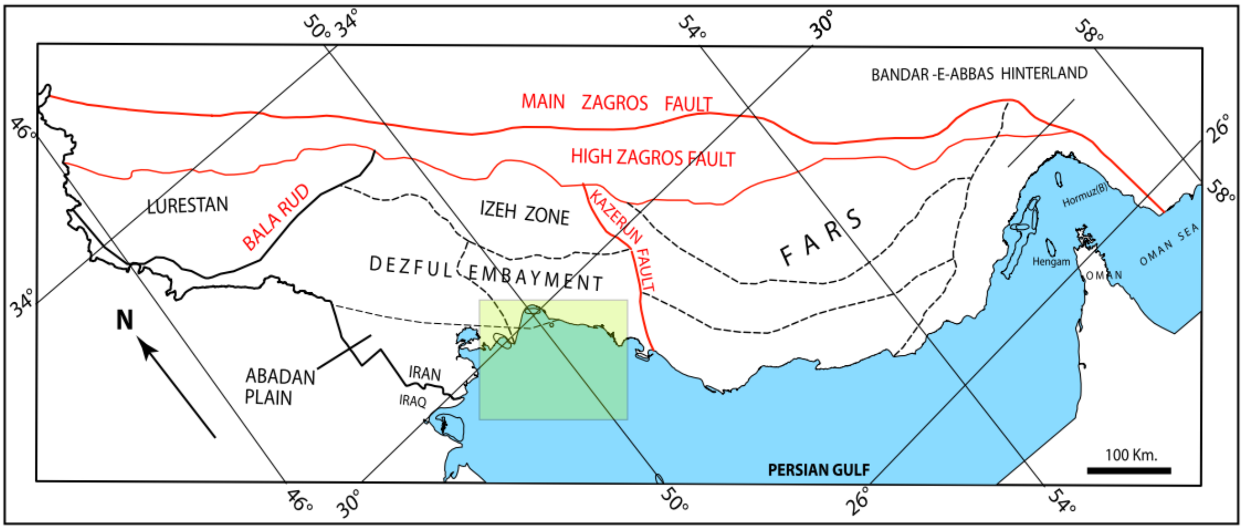


Fig 1: Stractural zones of the Zagros and location map of the study area.

They determined two ages for folding in this area, the older took place in the late Cretaceous and the younger occurred in the Paleo- Quaternary. They believed that, N-S, NNE- SSW trending folds were formed during the late Cretaceous, affecting younger formations. Two depositional models (Fig 2 and 3) are constructed based on well data and seismic interpreted geometries to introduce stratigraphic traps within the studies interval and area. Based on the model in Figure 3 along with seismic profiles (Fig 4, 5 and 6 and wells #D, E and F) from the Aptian to Santonian, these highs are considered uplifting. As a result, the thickness of the formations at the highs decreases relative to their surroundings. Extreme activity during the Coniacian age (Abdollahie-Fard et al. 2006) led to the removal of the Laffan and Ilam formations near the top of the Hendijan Structure. The coniacion age represents the maximum activity during which the Laffan and Ilam formations were not deposited or preserved near the Hendijan structure top. These two formations towards the Hendijan paleohigh gradually pinche out. The objectives of this study were first, to investigate the Upper Cretaceous Petroleum System ofthe northwestern Persian Gulf and second, to create a geological model to interpret stratigraphic trap formations in Upper Cretaceous reservoirs.

2. Material and Methods

The study of the seismo-stratigraphic events of the late Cretaceous in the Persian Gulf included the interpretation of 2D seismic lines and the investigation of six wells (A, B, C, D, E and F). The exploratory wells penetrate to the Neocomian strata and contain litho-biostratigraphic logs. For correlation purposes, the top of the Khalij Member (Barremian) was used as a datum line to control the vertical and lateral biofacies and thickness variations of the studied wells (Fig 3). Several thin sections of the Sarvak to Gurpi formations interval were sedimentologically and micropaleontologically studied in six of the wells in order to identify depositional environment.

The PC 2000 seismic survey provided the primary data set for this study. Seismic interpretation was comprised of 28,000 km of 2D data. The seismic grid was made up of 2 km × 2 km line spacing oriented northwest to southeast and northeast to southwest. The seismic data was tied to key wells throughout the studied area and synthetic seismograms were generated for some of these wells. It should be noted however, that the quality/position of the seismic ties was not always conclusive. For this reason, the time-depth position of the formation’s top was more often used as the determinant for seismic interperatation.The top of the Ilam Formation reflector is a medium coufidence seismic pick. Because acoustic impedance sections better show the properties of layers and are easier to interpret, model based inversion was applied to some of the lines in order to change the reflectivity to acoustic impedance.These inverted lines were used to modify previous interpretations.

3. Geological Setting

The lithostratigraphic units in this study included the Albian Kazhdumi, Cenomanian Sarvak, Coniacian Laffan, Santonian Ilam and Santonian to Maastrichtian Gurpi formations. Each of these units plays an important role in the petroleum system. The Sarvak and Ilam formations consist of thin to thick bedded shallow-water carbonates with shale interbeds, which laterally die out inthe paleohigh areas (Fig 4, 5 and 6). These formations were sealed by the Kazhdumi (shale and marl) and Gurpi formations at the base and top respectively (Fig 4, 5 and 6).

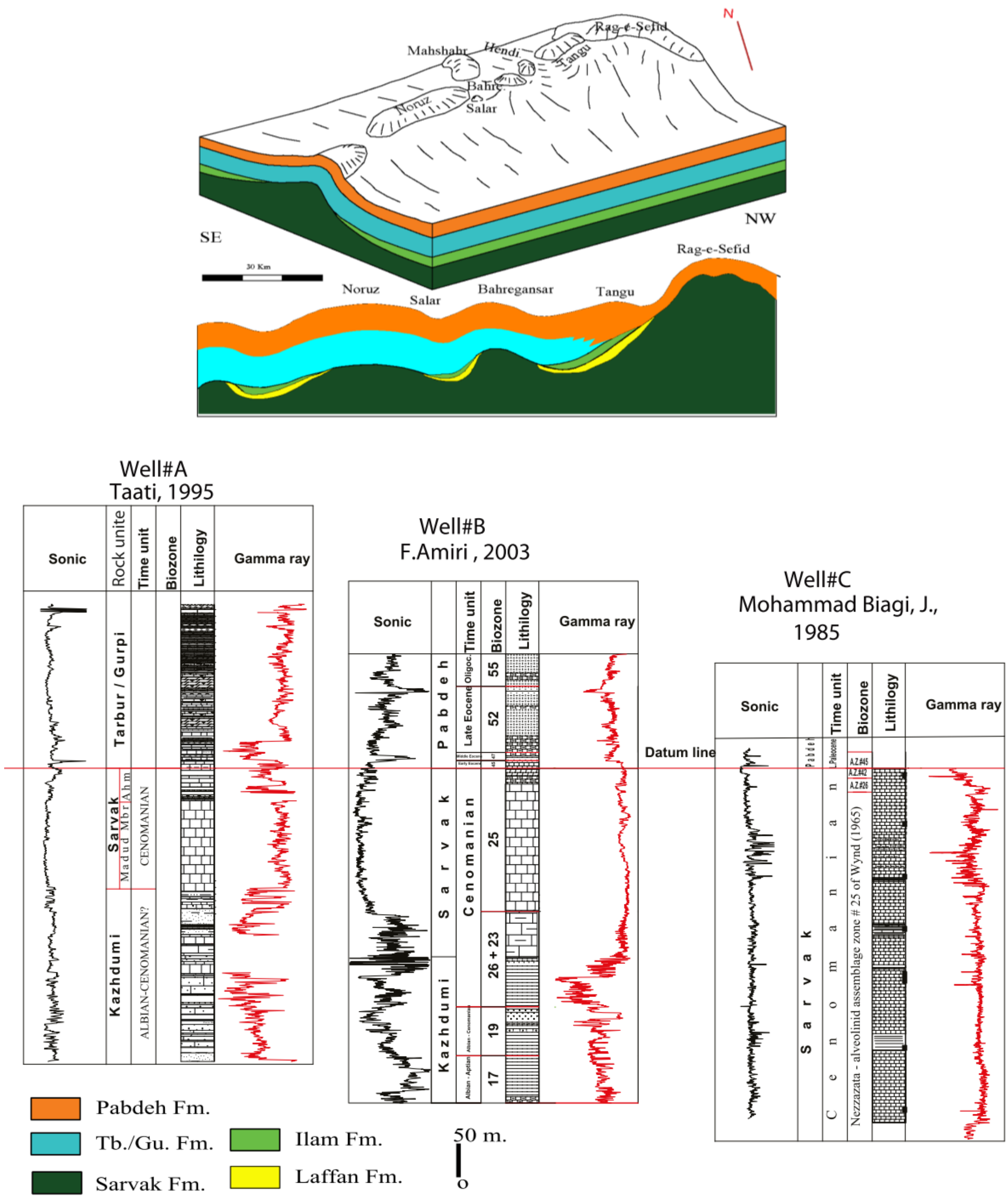


Fig 2.A Tectono-stratigraphy model of upper Cretaceous formations on and near the Nowrooz- Bahregansar- Hendijan- Tangu- Rage- Safid paleohigh based on the wells data (A, B and C) and seismic interperatation.

Paleohigh-related basin morphology and sea level fluctuations are the main controls on the sedimentary patterns and facies changes throughout the area by which compound hydrocarbon traps could be developed (Fig 2 and 3). The tectonic setting of the above mentioned stratigraphic units was strongly influenced by a number of paleohighs and troughs (Fig 2 and 3). These paleohighs were created and affected by great tectonostratigraphic events before, during and after the Cenomanian deposition, leading to different patterns in the sediment distribution. Most of the exploration Wells of the NW Persian Gulf are located along two general S-N trending paleohighs. The best-known paleo-high is the Nowrooz-Hendijan-Bahregansar- Reg-e- Safid- Izeh (Ashrafzadeh 1999; Abdollahie-Fard et al. 2006; Soleimany and Sàbat 2010; Soleimany et al. 2011). This paleo-high (A, B and C; Fig 2), lined up in an approximate N-S direction (Arabian trend), may have been raised by preexisting basement faults.

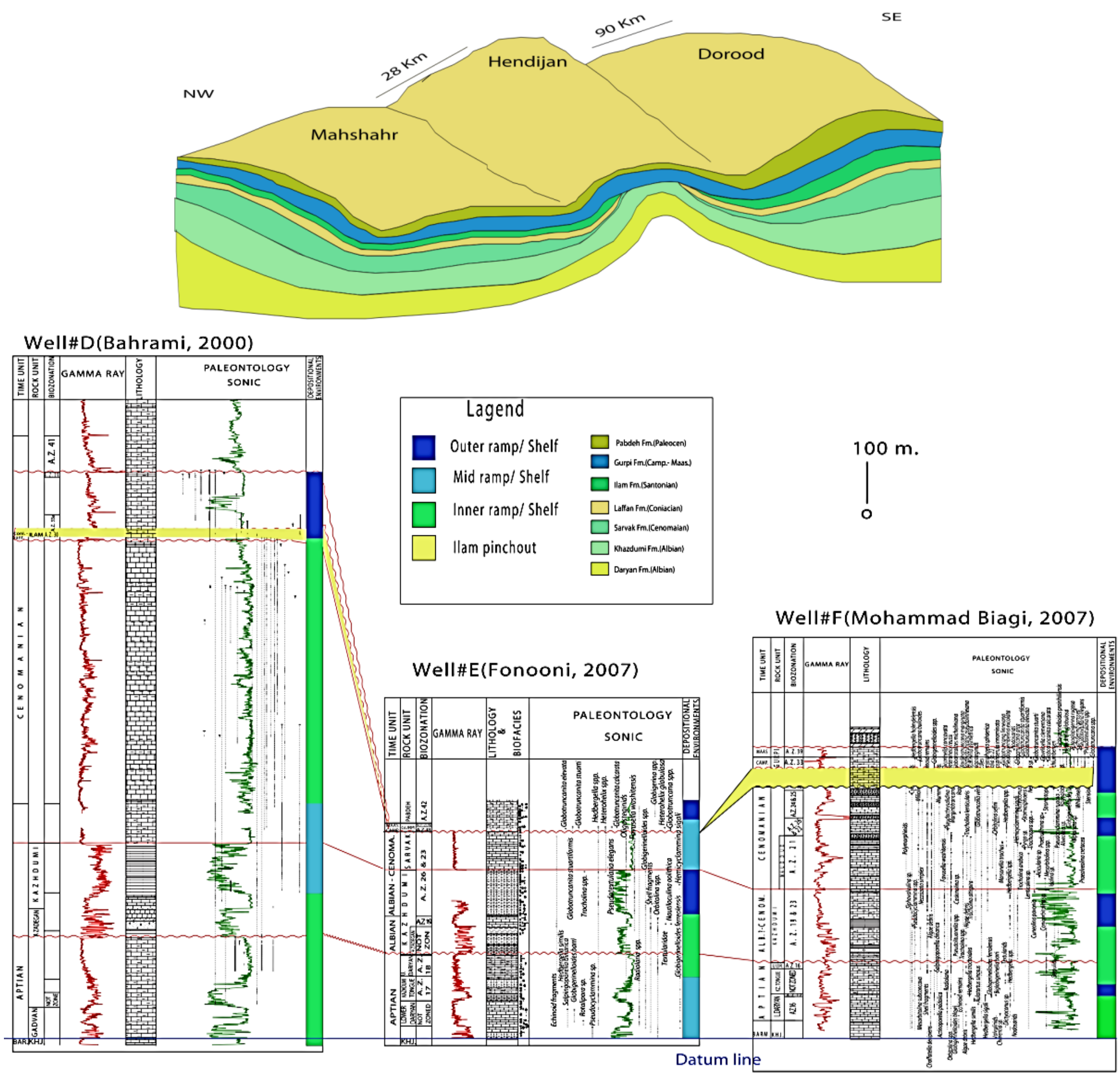


Fig 3. A model of Mahshahr, Hendijan and Dorood Paleohighs and its sedimentary succession based on the seismic interperatation and wells D, E and F data drilled. This model shows that Hendijan Paleohigh was in higher elevation compare to the two others from the Aptian to Maastrichtian due to thining units. Therefore the Ilam Formation pinches out and truncate toward the Hendijan paleohigh.

The Sarvak, Laffan and Ilam formations are preserved in the paleotroughs but have been reduced in thickness or eliminated at the paleohighs due to post Cenomanian-Turonian and Santonian unconformities. A major event took place both during and after the Cenomanian deposition.This is evidenced by the different sediments, variations in thickness and formation distribution. A large gap exists between the top of the Cenomanian Sarvak Formation and Early Eocene Pabdeh Formation in the Tangue ((Amiri (2003), based on the paleolog for Well B, Fig 2) and Rag - e - Safid paleohigh ((Mohammad Biagi (2007), 1985, based on the paleolog for Well C, Fig 2).This gap much shorter toward the Nowrooz- Hendijan-Bahregansar structures where the Campanian-Maastrichtian Gurpi Formation directly covers the Sarvak Formation ((Taati koraiem (1975), based on the paleolog for WellA, Fig 2). The Kharge-Mish High is another paleohigh oriented in an approximate NNE and SSW direction. Abdollahie-Fard et al. (2006) studied the seismo-tectonostratigraphy of this high along with the adjacent area (Abadan Plain and Dezful Embayment).

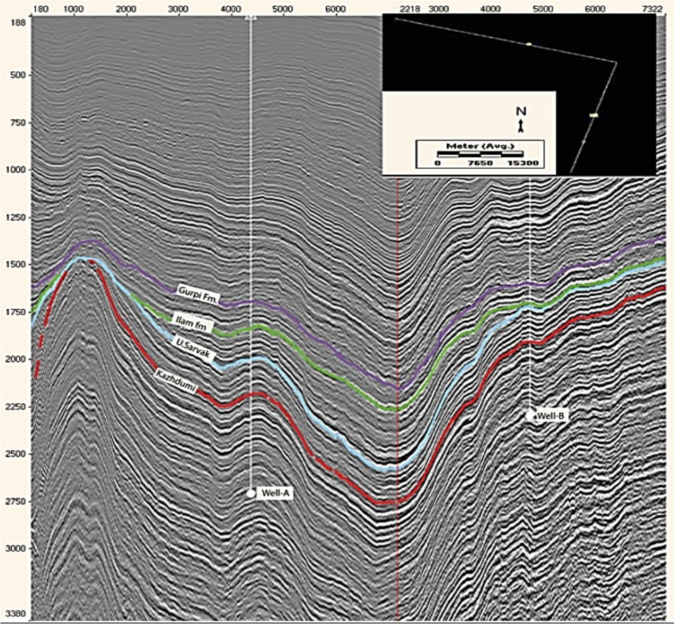


Fig 4. Seismic interpretation of two dip and strick lines showing a typical pinch-out of Ilam and Sarvak formations. Based on these lines Upper Sarvak and Ilam formations were truncated near the paleohighs. Ilam and Sarvak formation was sealed by Gurpi marls at the top, and Laffan/Kazhdumi shale at the middle and base. The Laffan reflector can not be picked due to low seismic vertical resolution.(e. g. wells A and B at top of paleohighs).

They believe that activity peaked in this high during the Coniacian period creating great facies and thickness variations in the Santonian to Maastrichtian intervals.The Sarvak and Ilam formations also exhibit great thickness and facies variations. In the deeper environments (paleotourghs) these formations are chracterised by very thick plagic sediments such as oligostigina facies (Plate 1, Fig 1 and 3) grading to benthic facies (e.g. rudist debris) near the paleohighs (reservoir rocks, Plate 1, Fig 4 and 8). The Late Cretaceous period of the studied area is marked by an obduction of the Neo-Tethyan sedimentary cover and ophiolites over the Arabian Platform (e.g. (Szabo and Kheradpir 1978; Boulin 1991; Polat et al. 1996; Alavi 2004; Piryaei et al. 2010; Soleimany and Sàbat 2010). It is also associated with the creation of a foreland basin along the NE Arabian Plate boundary that covers the studied area.The upper Dariyan (Aptian) and Sarvak Formations along with the lower and upper contacts of the Gurpi Formation coincide stratigraphically with four well-known unconformities, increasing the reservoir characteristics.

4. Source, Reservoir and Cap Rocks

4.1. Source Rocks

The Llandoverian Sarchahan Formation comprises most of the organic source rock of the area and is comparable to the Qusaybah hot shale of Saudi Arabia (Bordenave 2008). Other source rocks including the rich, organic layers of the Cambrian Milla Formation, Permian Dalan and Triassic Kangan formations could potentially have produced a small amount of oil. Two Silurian basins are suggested; the first extends from Oman to Bandar Abbas and the second extends into Saudi Arabia, western Qatar, Iraq, Jordan and the Dezful Embayment (Bordenave 2008). These two basins were separated by the Gavbandi-Qatar Arc where the Silurian hot shale was not deposited or eroded during the Pre-Permian. The petroleum system in the area includes Permian and Early Triassic carbonate reservoirs (Dehram Group). They are sealed by the evaporates of the Dashtak Formation (Bordenave 2008). Where this formation is massive and well-developed, the Paleozoic petroleum system is separated from younger petroleum systems. Petroleum sourced from the Llandoverian shales migrated to the overlying reservoirs of the lower Cretaceous Khami Group, Oligo-Miocene Asmari and Jahrum formations and Guri Member of the Mishan Formation. National Iranian Oil Company and Total Fina Elf in a joint study focused on determining the geochemical characteristics and hydrocarbon potential of the Cretaceous source rocks contained in the Iranian sector of the Persian Gulf from the Strait of Hormoz to the northern Persian Gulf extending into the Abadan Plain. Source rock potential was demonstrated in different stratigraphic units. The most desirable characteristics were found in the Pabdeh (Eocene), Kazhdumi and Sarvak/Khatayah (Middle Cretaceous), Garau (Lower Cretaceous) and Sargelu (Jurassic) formations while poor potential was found in the Gurpi (Upper Cretaceous) and Gadvan (Lower Cretaceous) formations.

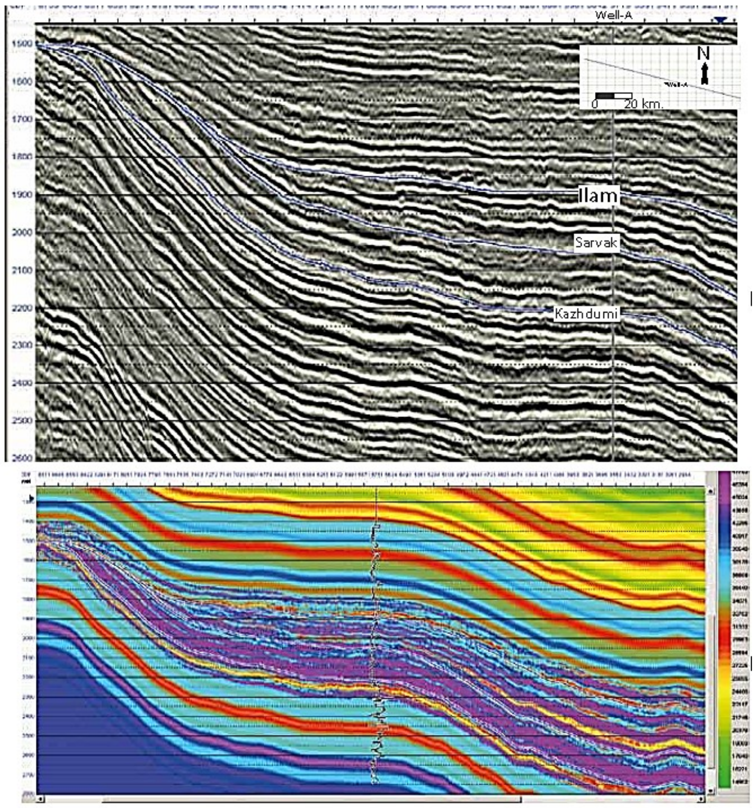


Fig 5. a) The Upper Sarvak and Ilam formations pinch out from southeast to northwest towards. They are completely truncated near top of the paleohigh. b) Inerpretation of the inversion of the fig. 5A showing different lithologies.

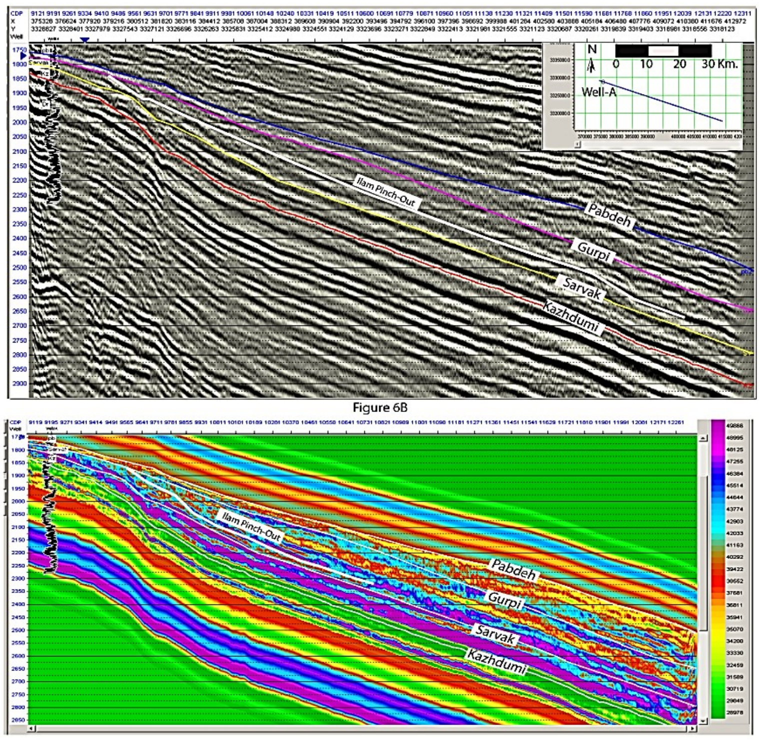


Fig 6. a) The Ilam Formation pinches out from SW to NE towards another paleohigh in the area. It is completely truncated near top of the Hendijan paleohigh. b) Inerpretation of the inversion of the fig. 6A showing different lithologies.

According to NIOC/TFE (2002) classification of oils, group D oils were restricted to the northwest correlating to Garau source rock while group F oils extended from the northern Persian Gulf to the Abadan Plain andcorrelated toKazhdumi source rock. Due to its geochemical characteristics and significant thickness, the Garau Formation is considereda good source rock. The Sargelu Shaly Formation, which exhibits good oil prone potential, is limited to the northwestern portion of the study area while the Jurassic southeastern portionis mainly comprised of carbonate facies (Surmeh) with a low overall Total Organic Carbon (TOC) content.These potential source rocks are well described by James and Wynd (1965); Bordenave and Sahabi (1971); Bordenave and Burwood (1995); NIOC/TFE (2002); Bordenave and Hegre (2005); Bordenave and Hegre (2010).

4.2. - Reservoir Rocks (Upper Cretaceous)

The main reservoirs in the Upper Cretaceous are as follow:

4.2.1. Albian to Turonian Sarvak Formation

The best reservoir facies include rudist packstone (Rudistic debries zone 24 of Wynd (1965)) and Nezzazata-Alveolina packstone to grainstone while, Orbitolina-Trocholina packstone to grainstone is considered less desirable.

The Sarvak Formationis regionally subdivided into three members (Mauddud, Ahmadi and Mishrif). In the high areas, the Mishrif Member (limestone) shows erosion or lack of deposition due to post-Cenomanian tectonic activity. In the surrounding area, this member deposition took place in a neritic shelf environment containing rudist facies resulting in the development of a reservoir facies in the Sarvak (Plate 1, Fig 7). The basinal facies (Oligostegina and Radiolaria) of the troughs developed as sealing deposits in subsequent stages, while thin-bedded plagic limestone was deposited between the high and trough.

4.2.2. Santonian Ilam Formation

During the Turonian (Upper Sarvak Formation) and Santonian (Ilam Formation) age, the Nowrooz, Hendijan, Bahregansar and Izeh paleohighs moved upward (Fig 2) and became separated by trough zones where the sedimentation of the thin-bedded Oligostegina limestone took place.The Santonian neritic facies over the paleohighs is attributed to the grading of the Ilam Formation into the pelagic facies of the Gurpi Formation depressions.The faunal assemblage of the Ilam Formation corresponds to biozone 30 of Wynd (1965) and contains Rutorbinella sp. (Rotalia sp.22) and rudist debries (Plate1, Fig 4 and 8), while the pelagic sediments are dominated by oligostegin facies (Biozone 26 of Wynd (1965)) and planktonic foraminifers (Plate1, Fig 1). The Ilam Formation is underlain by either the Coniacian Laffan, Turonian or Cenomanian Sarvak formation. In some portions of the north western Persian Gulf such as Nowrooz -Bahregansar-Hendijan- Izeh and Kharg-Mish paleohighs, the Santonian Ilam Formation show no depositon or it has been eroded (Abdollahie-Fard et al. 2006). The eroded shallow-water carbonates were bypassed in favor of the deeper parts of the basin during the sea levels fall leaving signs of forced regression or an onlapping pattern near the paleohighs. These wedge-type sedimentary packages could have hydrocarbon potential in the exploration strategy (Fig 4, 5 and 6). While the primary porosity may be high locally, the fissuring of the rock by later tectonics seems to be the main reason for good reservoir development. The subsequent transgressive system tracts (Gurpi marls), may cover the underlying reservoir units.

4.3. Cap rocks

The most commonly sealing rocks for the Bangestan Group calcareous formations include the Gurpi, Laffan and Kazhdumi formations introduced based on position as follows:

4.3.1. Top Sealing

Gurpi Formation (Campanian- Maastrichtian) Several factors influencing the quality of cap rock are considered. The most important are:

4.3.1.1. Lithology composition

One of the important factor in quality determination and efficiency (operation) of cap rock is related to the lithology of sealing formations, such that where the lithology comprises marl or shale, with enough thickness, it acts as good seal, but where the lithology is limestone or argillaceous limestone it tends to be a critical factor in a petroleum system. In a majority of the studied area, the Gurpi Formation ranges from Santonian to Maastrichtian in age. According to James and Wynd (1965), both the top and bottom contacts of this formation are discontinuous at base and top respectively with the Santonian Ilam Formation and Paleocene Pabdeh Formation. In areas away from the foreland basin, the Gurpi Formation consists entirely of basinal pelagic facies such as in Well# A, (Plate-1, Fig 15). In the proximal portion and more active tectonic settings, the Gurpi Formation frequently interbeds with carbonates originating from the time equivalent Tarbur Platform and radiolarite-ophiolitic nappes.The basinal pelagic facies of this formation has sealed the Bangestan Group while carbonate layers (equivalent to Tarbur Formation) contain reservoir facies sealed by the shale and marl of the Paleocene Pabdeh Formation.The sediments of this formation are comprised mainly of argillaceous limestone to pelagic marls overlying the Sarvak Formation on the Nowrooz-Bahregansar – Hendijan –Rag-e Sefid high. The Gurpi deposits of Campanian age are composed mainly of planktonic fossils from the Globotruncana Stuarti–Pseudotextularia varians # 39, Abathomphalus mayaroensis # 40 and Globorotalia–Globigerina daubjergensis # 41 biozones of Wynd (1965) k formations.

4.3.1.2. Faults, Joints and Fractures

Most of the structures in the area have been active since late Paleozoic (Nairn and Alsharhan 1997), and many of them were created by Hormoz salt activity (Edgell 1991). The basement ancient faults trending N-S, after opening of Neo-tethys in Permo- Triassic were activated to control thickness and facies of Mesozoic sediments (Bahroudi and Talbot 2003; Soleimany and Sàbat 2010). Faults although in some occasions may play role of the seal but they are often the main conduit for escape and migration of hydrocarbon from petroleum traps. Their existence or absence is an important parameter to evaluate the quality of a good seal.

4.3.1.3. Diagenesis

Sediments through geological time, passes several diagenetic conditions. These conditions can be considered as cyclic steps in which rock- fluid system shifts from its thermodynamic equilibrium resulting in new rock- fluid reactions. These reactions appear as cavity, cementation, dolomitization etc. Dolomitization is one of the most important and most common types of metsomatism in limestone or shaly limestone. It is a process in which limestone or other sediments due to the replacement of primary calcium carbonate by magnesium carbonate from magnesium bearing waters change partly or completely to dolomite. Dolomite is a rombic mineral with the formula $CaMg(CO_3)_2$.

In the other hand, sulphur existence in formation fluids is important in diagenetic processes. Hydrothermal fluids while passing through evaporitic rock units or mixing with high H_2S-bearing hydrocarbons dissolve their sulphur. High sulfur waters while percolating through high-Mg limestone dissolve and carry Ca^{++} as aqueous $CaSO_4$ from ambient increasing Mg/Ca ratio in remaining rock (Sharp et al. 2010). By this process high-Mg limestone changes gradually to dolomite with 12% reduced volume leading to intracrystalline porosity increase in the affected zone. Dolomitization is a main diagenetic process in Sarvak to Gurpi formations in the Well# A.

These formations along faults, joints and fractures (weak points) due to chemical reactions between hot waters containing magnesium and calcium from limestone and argillaceous limestone has changed to dolomite. This event especially happened in upper part of Sarvak comprising 35 m. and Gurpi formations, secondary dolomite and rarely primary dolomite. Through the whole succession, selective dolomitization has happened abundantly in micritic matrix. Some of the studied thin-sections include scattered dolomite crystals and some others were completely dolomitized (Plate1, Fig 9 and 10).

Scattered dolomite crystals in matrix are more observed. In the studied thin – sections of Sarvak to Gurpi formations, features such as aggregation of dolomites along solution veins and stilolites, existence of filling dolomites and their big sizes implies that weak points (joints) and likely burial conditions had important role in dolomite formation. Although dolomitization has increased the porosity in the Sarvak Formation in this well, but this phenomenon had destructive role in deposits attributed to Campanian-Maastrichtian (Gurpi Formation), resulting in removal of capillary sealing property and increasing brittleness property. These have facilitated vertical migration of hydrocarbon from Sarvak to Gurpi successions. Such these intervals represent reservoir facies (Plate-1, Fig 11 and 12). According to this well data (Nayebi 2010) the Gurpi interval includes biozones 33 and 39 of Wynd (1965) illustrating sedimentation in deep environment but due to dolomitization only traces of planktonic fossils (Gansserina gansseri, Globotruncana elevata, Globotruncana calcarata according to Nayebi (2010) of these two biozones were observed (Plate-1, Fig 13 and 14). This phenomenon (Dolomitization) was not observed in deeper areas due to different lithology (Marl and shale) and compaction of the sedimentary rocks.

4.3.2. Base Sealing

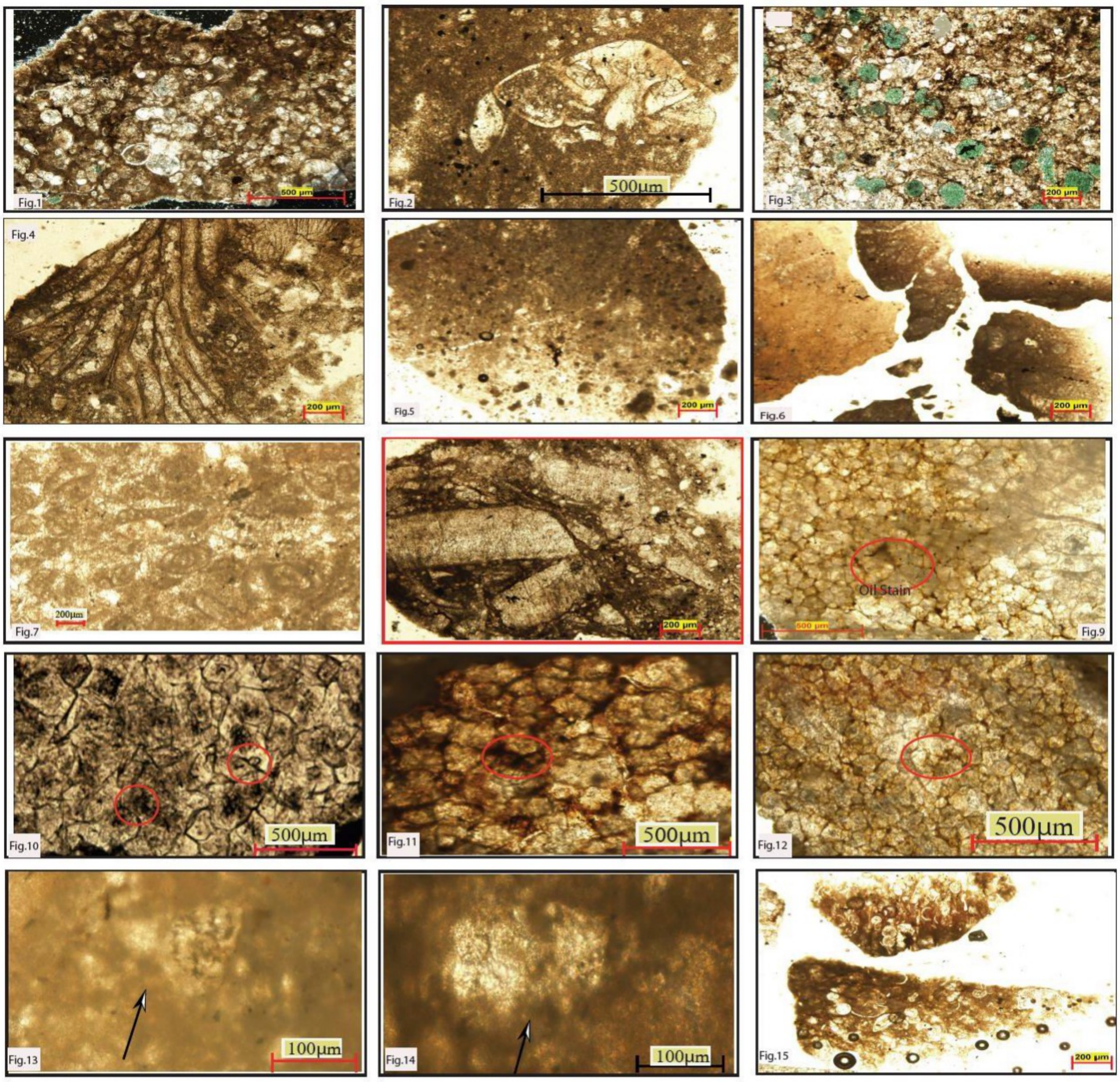
4.3.2.1. Laffan Shales (Coniacian)

In this area, the Laffan Member consists mainly of shale and argillaceous limestone. In the Persian Gulf, especially the northern portion, this member was created in a marine basin (including biozone # 26) and includes Pithonella and Oligostegina genera. In deeper areas (troughs), it also acts as source rock. In the Ilam Formation reservoirs, it acts as a bottom sealant giving a high value to the area it covers. Its spread in the studied area is limited. It was detected in theMahshahr Well A, Soroush Well A and Esfandiar Well A and may also exist in deeper parts (planges) of the structures. In Well A of Mahshar Field the Laffan Formation has a minimum thickness of 2 meters whereas the thickness in the extreme margins of the southeast and northeast show a remarkable increase. In the central portion of the studied area around the Bahman, Javan and Abuzar structures in a northwest trend, the maximum thickness reaches 84.5 m in the Binak WellA.The type section of the formation located in this well is comprised of gray shale with some limestone interbeds.

4.3.2.2.Kazhdumi Formation (Albian)

This formation consists mainly of gray to black shale. The lower contact of this formation with the Dariyan Formation (Aptian) is discontinuous while the upper contact with the Sarvak Formation is continuous and sharp.In a majority of the wells in the area, the basal portion of the formation is composed of clastic sediments belonging to the Azadegan Sandstone Member (Burgan sandstone) containing reservoir characteristics while the upper portionis made up of shale and carbonate sediments. In general, the Azadegan Member interfingers with shaly and carbonate parts. The lower part among its clastic facies includes sandy to shaly limestone interlayers bearing Orbitolina–Hemicyclammina biozone # 19 of Wynd (1965). This formation plays the role of source rock for the overlying Bangestan Group and the role of cap rock for underlying rock units.

Plate 1: Descriptions of the studied thin-sections from cuttings of the Wells



Oil staining

Fig.1: Planktonic foraminifera Packstone, Gurpi Fm., Well#D,
Fig.2: Rutorbinella sp.(Rotalia sp.22) , Ilam Fm., WeII#D
Fig.3: Planktonic foraminifera Packstone, Ilam Fm., Well#D
Fig.4: Rudist debries, Ilam Fm., Well#D
Fig.5: Argelious mudstone, Laffan Fm., Well#D
Fig.6: Argelious mudstone, Laffan Fm., WeII#D
Fig.7: Bioclast Wackstone, Sarvak Fm., WeII#D
Fig.8: Rudist debries bioclastic packstone, Ilam Fm., Well#D
Fig.9 and 10: Dolomitization in the Sarvak Fm., with oil staining, Well#A
Fig.1 1 and 12: Dolomitization in the Gurpi Fm., with oil staning , Well#A
Fig.1 3 and 14:Traces of planktonic foraminifera in the Gurpi Fm., Well#A
Fig.15: Oligostigina packstone, Gurpi Fm., Well#B

5. Conclusion

The study area contains paleohighs and troughs that play a critically important role in hydrocarbon accumulation.The paleohighs and surrounding area of the Cenomanian-Turonian Sarvak Formation and Santonian Ilam Formation contain benthic and rudistic facies. In the areas most distant from the highs, especially in the troughs, these facies grade into impermeable basinal sediment (Oligostegina, Radiolaria facies). The two most important reservoirs in the studied area are the Turonian Mishreif Member of the Sarvak Formation and the Santonian Ilam Formation deposited around the Nowrooz-Bahregansar-Hendijan-Reg-e-Safid and Kharg-Mish paleohighs. The Ilam and upper Sarvak are limited to the surrounding wedges and sealed by Gurpi Marl and shale at the top, Laffan /Kazhdumi shale at the base and facies variations laterally providing stratigraphic traps for hydrocarbon accumulation. These stratigraphic traps were later charged vertically and laterally by source rocks of the Jurassic Sargelu, Albian Kazhdumi and Neocomian Garau formations. A large gap exists between the top of the Cenomanian Sarvak Formation and Eocene Pabdeh Formation in the Tangue and Rag -e-Safid paleohigh. At the Nowrooz, Hendijan and Bahregansar structures, this is much shorter where the Campanian-Maastrichtian Gurpi Formation directly covers the Sarvak Formation.

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