Asian Journal of
Earth Sciences

ISSN 1819-1886

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Earth Sciences 7 (2): 27-39, 2014
ISSN 1819-1886 / DOI: 10.3923/ajes.2014.27.39

Depositional Evolution and Sediment Facies Pattern of the Tertiary Basin in Southern Zagros, South Iran

Payman Rezaee and Sajjad Abbas Ali Nejad
Department of Geology Science, University of Hormozgan, Bandar Abbas, Hormozgan, Iran

Corresponding Author: Payman Rezaee, Department of Geology Science, University of Hormozgan, Bandar Abbas, Hormozgan, Iran

ABSTRACT

Succession of tertiary strata in the Hormozgan province of southern Iran consists of predominantly carbonate deposits and characterized by marked changes in facies and thickness. These changes relate to sediment deposition in a foreland basin along the NE margin of the Arabian plate. In this study, stratigraphic evolution, microfacies are used to constrain the depositional evolution of the Tertiary sediments. The succession was measured at four outcrop and wells sections in the East Khamir, West Khamir, Namak and West Namak anticlines. The age of the base of the succession is Paleocene and its upper part is probably late Oligocene. The lower of the succession consists of interbedded wackestone to packstones of the Pabdeh formation. These strata are overlain by up to intrashelf deposit altered packston to grainstone (Jahrum formation) that may represent much of late Paleocene-Eocene time. The upper part of the Jahrum formation overlain by carbonate platform deposit (Asmari and Razak formations). We argue that the lithofacies and sediment- accumulation history of this succession based on these regional profiles, the tertiary depositional history of the Bandar Abbas area was reconstructed and can be divided into two tectono-sedimentary phases suggesting a transition from an active to a passive margin. The active phase (late Paleocene) dominated by pelagic marls, gravity flow deposits and lateral thickness variations. During passive phase dominated by Shallow-water facies consist mainly of packstones to grainstone with abundant benthic foraminifera. Rapid variations in thickness, Sequence stratigraphy and facies document the evolution of depositional processes in the foreland basin. In the study area, the foreland basin is characterized by a considerable SW to NE increase in stratigraphic thickness.

Key words: Depositional evolution, foreland basin, depocenter, Hormozgaan province

INTRODUCTION

The Zagros Fold-and-Thrust Belt (ZFTB), a part of the Alpine-Himalayan orogenic belt, is located in the northern part of Arabian plate. Situated at the eastern tip of the ZFTB (Bandar Abbas hinterland) and Persian Gulf (Fig. 1), the study area is situated at the junction of three geological systems namely: the Zagros Mountains, the Makran accretionary prism and the Oman Mountains. Orogenic belt, the Zagros is an 1800 km long mountain range extending NW-SE from the Taurus Mountains in NE Turkey (Scott, 1981; Smit *et al*., 2010) to the strait of Hormoz in Iran (Agard *et al*., 2007). The study area is located in the western and north part of the Bandar Abbas region (Hormozgan province). The Pleocene-Oligocene paleoenvironments of southern zagros are not well known. In particular, the Paleocene paleoenvironment has long been a matter of debate.

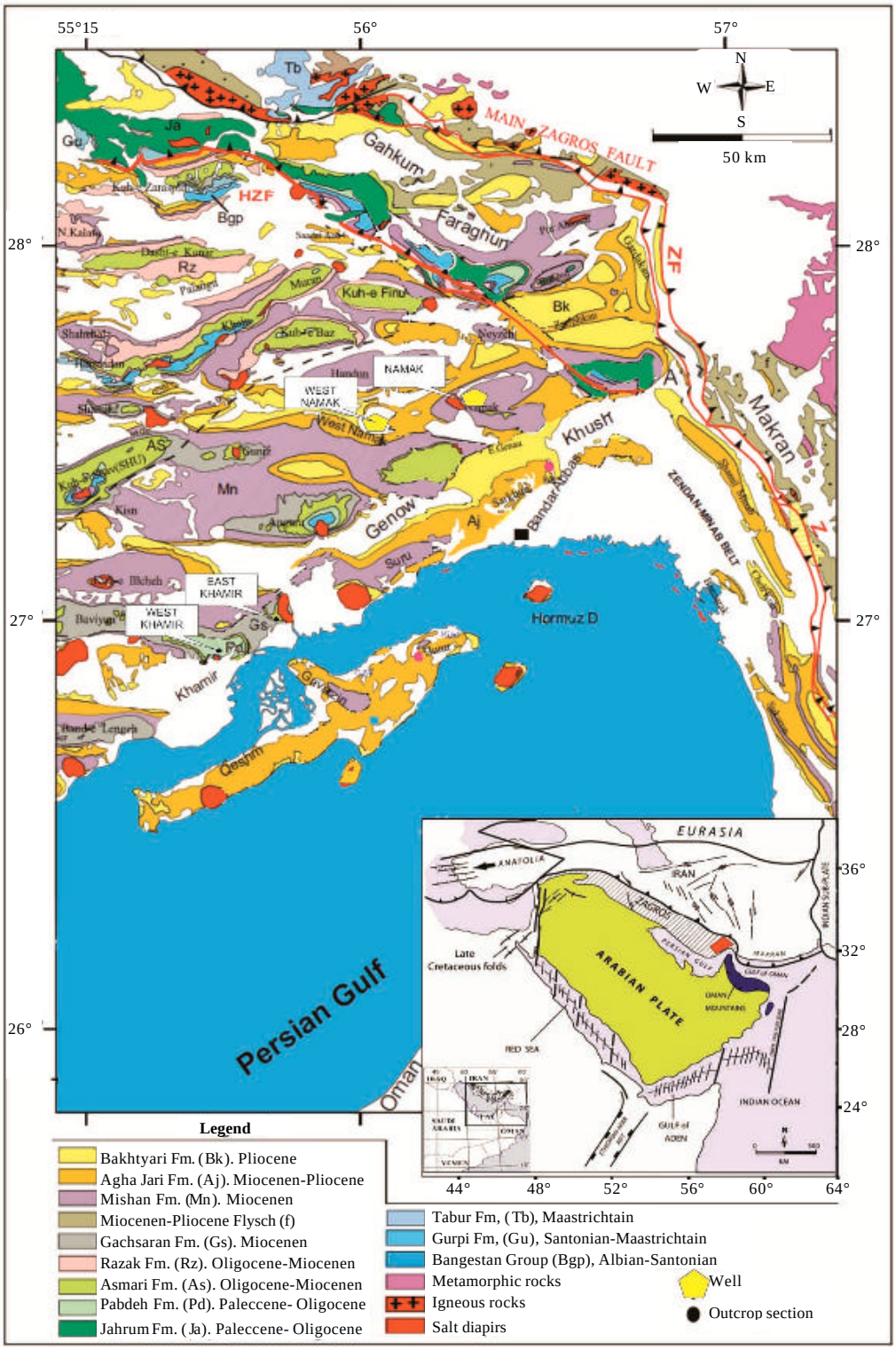

Fig. 1: Geological map of the Bandar Abbas area in Hormozgan province, southern Iran, showing the locations of outcrop sections and wells (modified from Fakhari, 2000)

The most comprehensive work on the Cenozoic lithostratigraphic units of the Zagros was carried out by James and Wynd (1965). That study was linked to a study addressing biofacies nomenclature of James and Wynd (1965). Other more recent, stratigraphic studies include those of Kheradpir (1975), Khalili (1976), Setudehnia (1978), Shakib (1994), Ghavidel-Syooki (2003) and Taghavi *et al.* (2007). A biostratigraphic study of the tertiary in the Zagros area was recently carried out by Van Buchem *et al.* (2001), Van Buchem *et al.* (2006), Piryaei *et al.* (2010) and (Piryaei *et al.*, 2011). The tertiary interval exposed in the study area comprises two lithostratigraphic units (1) the Paleocene to Eocene Pabdeh and Jahrum formations; (2) the Oligocene, Asmari and Razak formations. The aim of this study is to provide a detailed overview of the sedimentary architecture of the tertiary succession in the Hormozgan Province using field studies combined with well data. This study investigated depositional environment conditions and evolution of sedimentary environments at the tertiary depositions based on study of microfacies in two section (west and east Khamir) and two well (Namak and west Namak) in Hormozgan province.

MATERIALS AND METHODS

The study area is located in the southeastern Zagrosfold-thrust belt (Bandar Abbas area) (Fig. 1). It lies between the main Zagros thrust zone, the Kazerun Fault, the Razak Fault and the northern part of the Persian Gulf (Molinaro *et al.*, 2004; Alavi, 2004). This paper uses outcrop and well data from the onshore Bandar Abbas region. The field data based on sedimentological and stratigraphical analyses were complemented by petrographical studies. Two outcrop sections were logged in the west and east Khamir anticline (Table 1, locations in Fig. 1). The outcrop sections have a total thickness of approximately 1000 m, 400 samples were collected to thin-section analysis. Two wells in the Namak and west Namak anticline, which comprised of 450 m of sediments. The method used for this study comprises the detailed description of sedimentary features such as bedding geometry, textures, lithological compositions, faunal content and special surface. It was used of two wells (Namak and west Namak, Fig. 1), for which gamma-ray, sonic and palaeontological logs were available. Paleontological studies of foraminifera related to well successions were carried out in the Paleontological department of the NIOC (National Iranian Oil Company). About outcrop sections, biostratigraphic analysis of foraminifers was carried out on thin sections or washed (HF acid-etched) samples and microfacies were named by Dunham method (Dunham, 1962). The paleontological analysis of foraminifers, using the biozonation model proposed by James and Wynd (1965). The stratigraphic architecture of the tertiary interval was reconstructed based on high resolution sedimentary sequence analysis. Sequence stratigraphic interpretations were done based on the methods and nomenclature used for shallow-water carbonate systems (Van Buchem *et al.*, 2001). Finally, carbonate units microfacies and deposition

Table 1: Studied sections and their characteristics

Formation	Time range	Coordinates (GPS)	Section name
Pabdeh-Asmari	Tertiary	55°42′35 "E, 27°3′53"N	East Khamir
		55°42′15 "E, 27°2′9"N	
Pabdeh-Jahrum-Asmari	Tertiary	55°30′15"E, 26°57′43"N	West Khamir
		55°28′77"E, 26°59′53"N	
Jahrum-Asmari	Tertiary	56°9′156"E,27°30′33.3"N	West Namak
Pabdeh-Jahrum-Asmari	Tertiary	56°20′41.8"E,27°34′7.9"N	Namak

environment were determined based on Flugel (2010) facies belt. The outcrop sections were correlated with data of the wells and based on these data the evolution of sedimentary environments of tertiary was analyzed in this area.

RESULTS

Two outcrop sections were logged at the Khamir anticline (east, west) and two wells (west Namak, Namak) are described in details then compared with the logged sections (locations in Fig. 1).

East Khamir section: The east Khamir section is located in a valley, situated 3 km north of the Bandar-e-Pol city, in the eastern part of the southern flank of the Khamir Mountain. The exposed succession includes the Paleocene- Eocene, Pabdeh formation and the Oligocene, Asmari formation (Motiei, 1994). Founded sediments within the southern and northern flank are representing which there are significant facies differences in the short distance (Fig. 2). This section is representative of the Paleocene-Eocene slope to central foreland basin setting and Oligocene carbonate platform basin (Sherkati *et al*., 2004; Piryaei *et al*., 2011).

Gurpi formation: The section starts with the upper part of the Gurpi formation (10 m), consist of marl and thin-bedded limestone, nodular bedded, Bioclastic mudstone to wackestone which locally grades to packstone. Based on the faunal *Globotruncana stuarti*

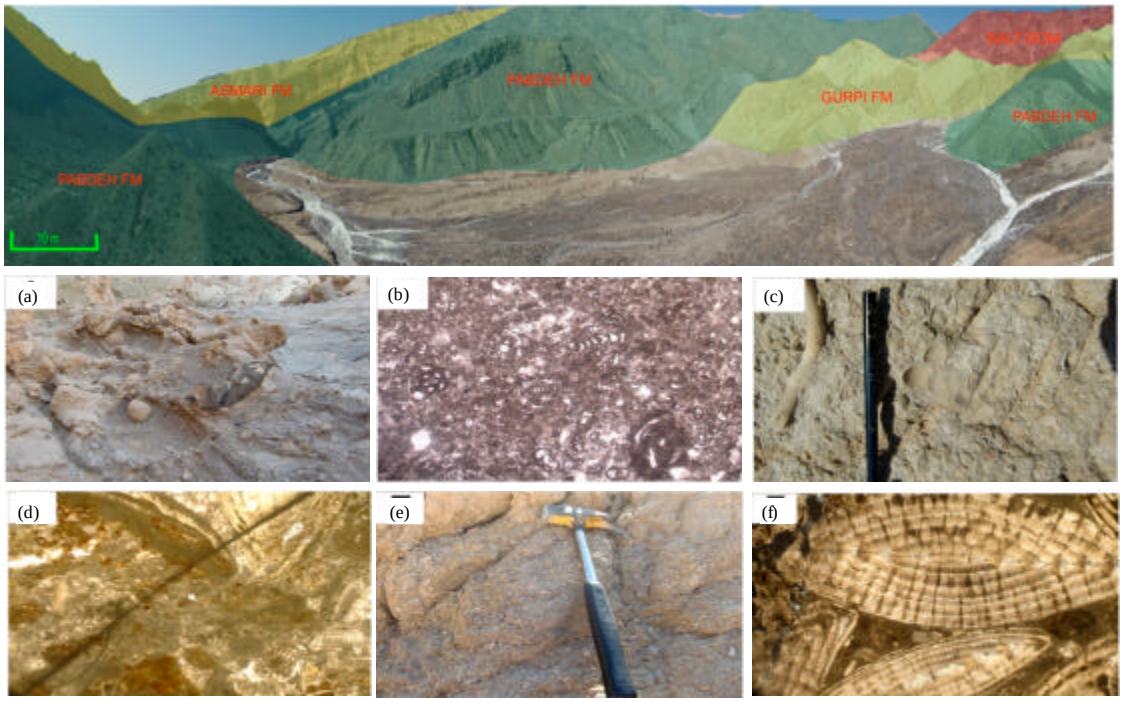

Fig. 2(a-f): Facies (a) illustrations of the Pabdeh formation, Microphotographs of (b) Bioclastic wackestone facies, (c) illustrations of the Jahrum formation, (d) Intraclast Bioclastic packstone, (e) illustrations of the Asmari formation deposits in the East Khamir area and (f) Bioclastic grainstone facies. 30x

zone; associated microfossils are *G. bulloides, G. Conica, G. Lapparenti, G. falsostuarti, Hedbergella* and *Heterohelix* the age is Lower Mastrichtian (James and Wynd, 1965).

Pabdeh formation: The Pabdeh formation reaches a thickness of 750 m and includes autochthonous facies. It can be subdivided into two units based on bedding pattern and sedimentary features. Base of Pabdeh formation starts with medium to coarse-grained, monomict conglomerates and followed by dark gray shale and marl with interlayers of thin bedded argillaceous limestone. Unit A (10-420 m) consists of thin to medium bedded layers of gray marl and marlstone interbedded with thin layers of argillaceous limestone and marl. The interval contains three cycles; each cycle starts with marl and ends with marly limestone showing a pelagic facies. Unit B (420-500 m) consists of argillaceous limestone interbedded with thinly bedded argillaceous limestone. Thin sections study of provided samples shows faunal components include planktonic and benthic foraminifers and pelagic facies with *Globorotalia* and *Globigerina* dominantly bioclast wackestone-mudstone, non-skeletal grains include pelloids (Einsele, 2000). Microfossils are dominantly planktonic (pelagic) foraminifera which shows biozone *Globorotalia velascoensis*, *Globorotalia centralis-Hant kenina* the age is suggests an Upper Paleocene-Eocene for this formation (James and Wynd, 1965). Pabdeh formation in this section is located beneath the Asmari formation.

Asmari formation: The Asmari formation reaches a thickness of 220 m and includes autochthonous facies base of Asmari formation starts with thick to medium limestone and alternative layers of gray thin to medium bedded argillaceous limestone, shale and marl at lower part which gradually change to medium to thick bedded limestone at middle and upper parts form the whole lithofacies of the formation.

West khamir section: The west Khamir section used in this study is positioned on the NW pericline of the anticline near the town of Khamir and lies with an east-west orientation. In these outcrops a continuous succession is exposed from upper Cretaceous to lower tertiary units. The Gurpi, Pabdeh, Jahrum and Asmari formations have been studied in great detail in this outcrop. Paleocene and Oligocene deposits are best developed in this section Gurpi facies are very thin and consists of marl to thin-bedded limestone with a pelagic fauna.

Pabdeh formation: The Pabdeh formation is fully exposed; reaches a thickness of 500 m disconformably overlies Tarbur formation and consists thin bedded bluish gray marl and marlstone associated with thin interlayers of argillaceous light cream limestone. Occasionally, sparse silt and fine sand within the marl form salty and sandy marls at intervals. Partly increasing of these grains forms thin layers of shale. It can be subdivided into four subunits based on the faunal composition and sedimentary cycles. The section starts with several decimeter-scale beds of carbonate marlstone and thin to medium-bedded pelagic mudstone to wackestone with planktonic funa. Thin sections study of provided samples Based on the fauna of the *Globorotalia velascosensis-Globorotalia pseudomenardi* assemblage zone (James and Wynd, 1965) a Paleocene-Eocene age is attributed to the sediments. Within the Pabdeh formation occur several clast dominated decimeters to meter-scale beds that contain radiolarite elements such as chert and clastic limestone rock fragments. A transition zone can be defined where interfingering is observed between the pelagic marls of the Pabdeh formation (Kameliazan *et al.*, 2000) and the benthic foraminifer-rich sediments derived from the nearby Jahrum formation observations.

Jahrum formation: In the main section the Jahrum formation is thin and consists of (240 m) thick to massive bedded limestone. Formation starts with several meter-scale beds of limestone and sediments consist of packestone to floatstone with echinoderm debris, algae and benthic foraminifers (*Rotalia, Dicyclina, Cuneolina, Cosklina*). Based on the fauna of the *Dictyoconus-Cosklina* assemblage zone (James and Wynd, 1965) Eocene age is assigned to this formation. Jahrum formation in this section has an interfingering relationship with Asmari formation.

Asmari formation: The Asmari formation (220 m) of this succession consists of thick to medium bedded bluish gray limestone and interlayers of argillaceous marl. There are also some beds of purple to bluish shale with a thickness of about 3 m overlied by thin layers of nodular and lenticular chert and occasionally limestones interlayered with marl. Sediments consist of grainestone to floatstone with echinoderm debris, algae and benthic foraminifers (*Rotalia, Dicyclina, Bigenerina, Nummiulites*). Based on the fauna of the elements of biozones 57 of (James and Wynd, 1965) indicating an Oligocene age.

West namak well: The west Namak well is located in 65 km north of Bandar Abbas city, in the central part of the northern flank of the west Namak mountain front. Late Cretaceous to Oligocene sediments is continuously exposed in this well. The Late Cretaceous part of this succession consists of the carbonate pelagic unit (Gurpi formation), the Paleocene-Eocene, which is attributed to the Jahrum formation, that consists mostly of muddy, large benthic foraminifer-dominated, shallow-water facies and Oligocene part, 50 m thick, consisting of bentic basinal facies dominated by bentic fauna (Asmari formation).

Jahrum formation: Juhrum formation has a maximum thickness approximately 500 m. This formation consists of two principal sedimentary units. (A) The lower unit is 300 m of argillaceous grainstone to packestones composed of massive shelf margin containing *Globigerina* and *Milolides* deposited in intrashelf setting. This unit show minor facies and thickness variations throughout the study area compared to the upper unit. (B) The upper unit consists of thin bedded, fine-grained, dark coloured argillaceous limestone with a rich pelagic fauna including *Aliveolina* (James and Wynd, 1965). Locally the Upper part is overlain by another shallow-water carbonate unit of the Asmari formation (Van Buchem *et al*., 2001). Based on this faunal assemblage the unit is attributed to the Linderina subzone (49) and *Dictyoconus-Cosklina* zone (50) of (James and Wynd, 1965), with an Eocene age is assigned to this formation.

Asmari formation: Asmari formation has thickness 50 m of argillaceous grainstone to packstones consists of platform carbonates characterized by *Rotalia,* algae, Nummulites and assemblages Zones 57 of (James and Wynd, 1965), indicating an Oligocene age. That developed in the NE part of the study area (Fig. 1). This formation relationship basinal facies of the Mishan (Guri Member) comprise grey, regular bedded, fine-grained argillaceous limestone with *Operculina, Valvulindes* and *Elphidium* benthic fauna.

Namak well: The Namak well are located in the core of the Namak anticline, approximately 75 km north of the Bandar Abbas city (Fig. 1). The exposed well includes the Santonian to Maastrichtian Gurpi, Paleocene to Eocene Jahrum, Pabdeh and Oligocene Razak formations.

Jahrum formation: The interval is sedimentologically divided into two units, A and B. The lower 50 m consists of thin to thick massive *Globigerina* dominated Intrashelf facies deposits. Consist of decimeter-scale, nodular bedded, bioclastic wacke to grainstones which alternate with dark grey limestone beds. The faunal assemblage includes *Operculina*, *Rotalia*, *Orbitolites* and rare radiolaria. An iron-stained surface occurs towards the base of the basal nodular limestone unit with patches of Glauconite. This surface can be considered as the Campanian-Paleocene unconformity (James and Wynd, 1965). The upper part (Unit B) comprises sediments deposited in a shallow-water setting. Deposits consist of decimeter-scale dark bluish grey intrashelf marls and shale with subordinate argillaceous limestones bedded, grainston to packestone containing *Orbitolites*. Based on the faunal assemblage, this interval corresponds to Linderina subzone and Dictyoconus-Cosklina zone biozone of (James and Wynd, 1965) and can be assigned to the Eocene age. The Jahrum formation is locally overlain by approximately 300 m of cyclic evaporate and Limestone of the Razak formations.

Pabdeh formation: Pabdeh formation has thickness 70 m thickness is characterized by thin too medium bedded carbonates consist of decimeter-scale, nodular bedded, bioclastic wacke to packstones which alternate with dark grey marly beds. The faunal assemblage includes *Globorotaliau* and *Globigerina* and rare radiolaria. This unit is attributed to the *Globorotaliau* facies biozone of (James and Wynd, 1965) with a Late Paleocene age.

Razak formation: The sediments of the Razak formation consist at this location of 175 m of thick bedded limestone and shale limestone intercalation evaporate deposed consist of echinoderm debris packstone- floatstone and massive grainstone to packstone with bivalve debris, miliolids, Orbitoidae, Dicyclina and other skeletal and non-skeletal grains. Based on the assemblages Zones 57 of (James and Wynd, 1965) Oligocene age is assigned to this formation. This formation is capped by tens of meters of the Mishan formation.

DISCUSSION

Interpretation of depositional system: Based on the microfacies and by comparing the outcrops and wells, three depositional systems can be recognized in the tertiary succession in the study area: pelagic, intrashelf and carbonate platform basin. This interval includes the Pabdeh, Jahrum Asmari and Razak formations. Environments in the study have a wide variety of lithology and sedimentary facies can be found. The stratigraphic relationships between these lithofacies are discussed in the biostratigraphy sections. Shallow-water sediments consist of packstone to grainstone with echinoderm debris, algae and benthic foraminifers (*Rotallia*, *Dicyclina*, *Cuneolina*) (Cojan and Renard, 2002; Erraioui *et al*., 2005). These sediments were deposited in intrashelf and carbonate platform basin (Jahrum Asmari and Razak formations) (Van Buchem *et al*., 2001, 2006). Locally interbedding with facies bearing pelagic fauna (*Globorotaliau* and *Globigerina*) can be observed, which is interpreted as a deep basin environment (Jenkyns, 1986). The tertiary carbonate sediments examined in this study represent an evolution from shallow water (Intrashelf, Platform Carbonate) to deep-water (pelagic) environments (Einsele, 2000). Because of the changing fauna and geometrical organization of the tertiary carbonate systems (Abdelghany, 2003); they are presented in chronological order. These sedimentary systems in each time interval can be related to a particular lithostratigraphic unit.

Deep basin pelagic facies (late paleocene-early eocene): The pelagic basinal facies were deposited in the deepest part of the basin during the Late Paleocene-Early Eocene (Pabdeh formation) (Katharina, 1981). The mudstones to packstones contain numerous types of planktonic foraminifers, such as *Globigerinids* and *Globorutalia* and various bivalves' species. The bedding pattern varies from millimeters to decimeters scale (Fig. 4). In the Khamir sections and wells (Namak). In these locations the very thin-bedded marly facies is sometimes interbedded with medium wavy bedded limestone intervals. These mud-supported carbonate facies contain iron nodules, tar sands and a considerable amount of echinoderm fragments, which sometimes occur associated with condensed surfaces and *Zoophycos* ichnofossils. The Paleocene basinal facies is well developed in the East Khamir and contains Bioclastic wackestone to Packstone (Fig. 2, 3). The faunal content of the basinal facies consists of a variety of planktonic foraminifers, *radiolaria*, *Globorutalia* and pelagic macrofossils in association with benthic elements reworked from the platform top. Compared with the underlying Paleocene pelagic facies, the sediments show different decimeter- to meter-scale bedding patterns that alternate with marly intervals.

Intrashelf basin (late paleocene-eocene): The upper Eocene interval is characterized by aclinoform-bearing platform margin geometry and a distinct intrashelf basin system that can be distinguished at outcrops and well sections (Jahrum formation). Intrashelf basins were common on the shallow margins of the Arabian Plate in Eocene time (Van Buchem *et al*., 1996, 2001) and several theories have been proposed for their development. The margins of stable carbonate platforms are susceptible to the effects of marine transgression. Since rates of tectonic subsidence are low, the geometry of the sedimentary fill will largely be controlled by eustatic sea-level

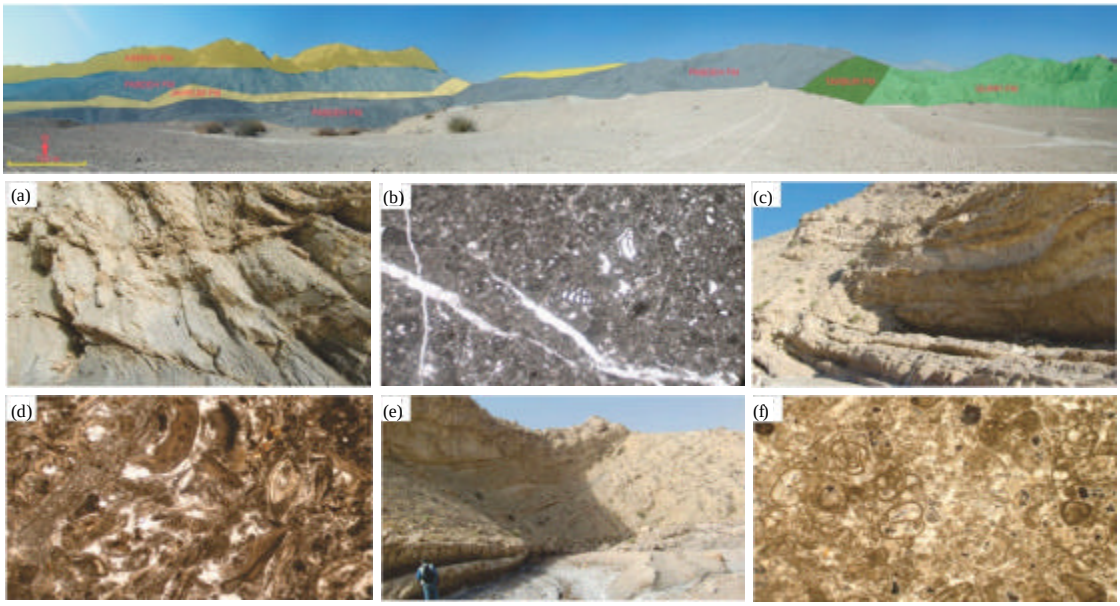

Fig. 3(a-f): Facies (a) illustrations of the Pabdeh formations, Microphotographs of (b) bioclastic wackestone facies, (c) illustrations of the Jahrum, (d) Bioclastic grainstone facies, (e) Asmari formations deposits in the West Khamir and (f) Intraclast Bioclastic packstone facies. 30x

fluctuations (Aigner *et al*., 1989; Van Buchem *et al*., 1996, 2001). Intrashelf basins may also form due to differential rates of sediment production. Most intrashelf basins are short-lived and may be filled during succeeding transgressions. The overall geometry of the Oligocene platform, in addition to observations made in the High Zagros, suggest that the intra shelf basin in the study area was 50 to 70 m deep. The intrashelf basin fill begins with flat or gently dipping reflections at the deepest point, progressively onlapping adjacent basin margins. The facies is interpreted to consist mainly of fine-grained deposits which are locally associated with turbidity deposits which have a Cosklina facies pattern. The onlapping nature of this facies, together with its tendency to selectively fill lows in the depositional topography, suggests that it was deposited by gravity controlled flows along the floor of the basin (Zambetakis-Lekkas and Kemeridou, 2006). This facies is medium to thick bedded (meters scale) packstone to grainstone contain benthic foraminifera such as *Rotalia, Dicyclina, Cuneolina, Cosklina* and bivalves, echinoderm debris is developed in the east Khamir, Namk and west Namak anticline.

Dominated platform carbonate (Oligocene): Several depositional environments can be distinguished in this depositional system, as follows (Meric *et al*., 2001). (1) The inner platform facies is characterized by mudstones to packstones, with *Orbitoides, milliolids, Dicyclina* and non-skeletal grains such as pelloids. (2) The open platform facies consists of echinoid and rudist debris wackestone-packstone. (3) The thick packages of coarse to very coarse grained bivalves-bearing limestone are interpreted as a high-energy barrier that occurred at the platform top. This facies is thick to massive bedded (meters scale) and shows considerable lateral and vertical Nummulites-dominated facies is developed in the Khamir, Namk and west Namak anticline.

Regional cross-sections and stratigraphic evolution and thickness variations: Four regional cross-sections were constructed through the wells and outcrops in the Bandar Abbas areas (profile locations are on Fig. 4). The characteristics from depositional history of this area can be divided into sequence, thickness and environments variations. The Paleocene-Oligocene interval is assigned to a three sequence. Sequence (1) is determined by the Paleocene and Eocene interval. Sequence (2) is determined by the Eocene interval and sequence (3) is determined by the Oligocene interval. These sequences can be correlated with those of Sharland *et al*. (2001) and Van Buchem *et al*. (2006) on the Arabian Plate. These environments variations illustrate the transition from pelagic basin to development of shallow-water carbonate platform associated with intrashelf and carbonate platform basin in the study area (Piryaei *et al*., 2010). During the Paleocene (Pabdeh formation), the sedimentary system consisted of pelagic facies with associated shallow water carbonate platform. Platform deposits are characterized by *Rotalia* sp., algae and Pseudedomia, basinal facies include *Globigerinids* and *Globorutalia*.

Khamir sections show that Paleocenepelagic sediments developed in the SE (Pabdeh formation), then wedge out in the central portion of the sections and grade platform carbonates into in the NE (Jahrum formation), suggesting flexure of the carbonate platform and erosion in the SW. The Eocene-Oligocene interval remained shallow-marine in the west, East Khamir section and was composed of shallow-water platform carbonates in the wells (west Namak and Namak). Paleocene deposit occurs throughout the Khamir area and mainly comprises pelagic marls, frequently interbedded with marls and limestone deposits during the Paleocene. In the, West and east Khamir and wells successions (Eocene) shows an overall pelagic marls as shallowing trend (Jahrum formation) but in other hand on the wells, benthic foraminifera-bearing (Jahrum, Asmari and Razak formations) shows the shallow-water carbonates and intrashelf basin.

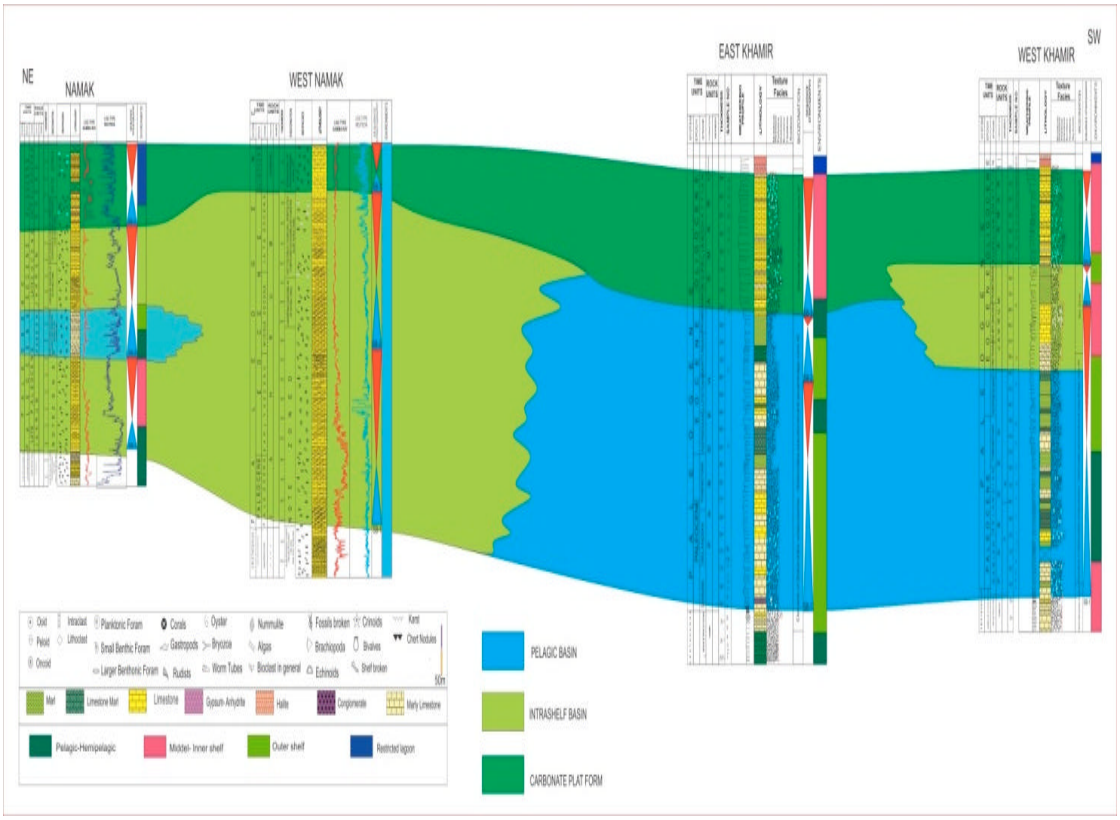

Fig. 4: Foreland basin profile: SW-NE cross-section through the west Khamir, east khamir, Namak and west Namak sections showing facies and thickness variations in this study area

Thickness variations and associated facies transitions are evidence for this transition, while the change in regional-scale environments led to considerable change in accommodation along a WSW-ENE trend. This is shown by significant increases in the thickness of Paleocene-Oligocene sediments in the study area. The Paleocene was associated with increased tilting of the foreland basin, thus creating a continental platform between the Arabian and Iranian plates (Murris, 1980; Robertson and Searle, 1990). Cross-sections shows illustrates the wedging-out of Paleocene shallow-water carbonates from the Namak and west Namak wells and then an abrupt thickness increase to a few hundred meters consist basinal facies include *Globigerinids* and *Globorutalia* of pelagic facies in the east Khamir section (Fig. 4). By contrast, the Paleocene to Eocene interval shows a marked lateral increase in accommodation from the Khamir section in the SW to the depocentre of study located in the east Khamir anticline as indicated by a thickness of 700 m. The Paleocene and Eocene interval represents an increase in accommodation in the SW, with low accommodation in the NE (west Namak and Namak wells) suggesting salt activity (Jahani *et al*., 2007, 2009). Cross-section West Namak and Namak in the Oligocene very similar to Khamir sections showing a trend of increasing accommodation from SW to NE. In this cross section, thickness variations indicate general deepening from the Khamir anticlines (Fig. 4), consistent with the stratigraphy profiles in Fig. 4. The figure illustrates an increase in thickness toward the SW, suggesting an increase in accommodation space during foreland basin creation.

East Khamir section shows an anomalous thickness (700 m) with respect to nearby section (average 300 m), which could be related to maximum development of foreland basin during the Paleocene to Eocene.

CONCLUSION

Deposits of the Paleocene-Oligocene Pabdeh, Jahrum, Asmsri and Razak formations on the Hormozgan Province were deposited in forland basin and platform system. Facies analysis indicates deposition ranging from basinal, intrashelf and carbonate platform environments. In this region of folded zagros, Pabdeh formations with Wackestone microfacies is related to pelagic environment and Jahrum, Razak, Asmari formations with packstone-grainstone microfacies show shallow marine condition (intrashelf). By contrast, the Paleocene to Oligocene interval shows a marked lateral increase in accommodation wedge-shaped deposits from the SW part of the study area. The depocenter and related to maximum development of foreland basin of during the Paleocene-Eocene was located in the SE as indicated by a thickness and facies. The depocentre of study located in the east Khamir anticline as indicated by a thickness of 700 m.

REFERENCES

Abdelghany, O., 2003. Late Campanian-Maastrichtian foraminifera from the simsima formation on the Western side of the Northern Oman Mountains. Cretaceous Res., 24: 391-405.

Agard, P., L. Jolivet, B. Vrielynck, E. Burov and P. Monie, 2007. Plate acceleration: The obduction trigger? Earth Planet. Sci. Lett., 258: 428-441.

Aigner, T., M. Doyle, D. Lawrence, M. Epting and A. van Vliet, 1989. Quantitative Modelling of the Carbonate Platforms: Some Examples. In: Controls on Carbonate Platform and Basin Development, Crevello, P.D. (Ed.). Society of Economic Palaeontologists and Mineralogists, Tulsa, Oklahoma, pp: 27-37.

Alavi, M., 2004. Regional stratigraphy of the Zagros fold-thrust belt of Iran and its proforeland evolution. Am. J. Sci., 304: 1-20.

Cojan, I. and M. Renard, 2002. Sedimentology. 1st Edn., Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, India, pp: 388-418.

Dunham, R.J., 1962. Classification of Carbonate Rocks According to Depositional Texture. In: Classification of Carbonate Rocks, Ham, W.E. (Ed.). American Association of Petroleum Geologists, Memoir, USA., pp: 108-121.

Einsele, G., 2000. Sedimentary Basins: Evolution, Facies and Sediment Budget. 2nd Edn., Springer-Verlag, Germany, ISBN: 354066193X, Pages: 792.

Erraioui, L., E. Srasra, F. Zargouni and K. Tajeddine, 2005. Petrological and physico-chemical investigations on an Tunisian glauconitic deposit. J. Phys. IV, 123: 71-74.

Fakhari, M., 2000. Geological Map of Bandar-E-Abbas, 1:250,000 Series. National Iranian Oil Company Publications, Iran.

Flugel, E., 2010. Microfacies Analysis of Limestones. Springer-Verlag, Berlin, Germany, ISBN-13: 9780387112695, pp: 633.

Ghavidel-Syooki, M., 2003. Palynostratigraphy of devonian sediments in the Zagros Basin, Southern Iran. Rev. Palaeobot. Palynol., 127: 241-268.

Jahani, S., J.P. Callot, D. Frizon Delamotte, J. Letouzey and P. Leturmy, 2007. The Salt Diapirs of the Eastern Fars Province (Zagros, Iran): A Brief Outline of their Past and Present. In: Thrust Belts and Foreland Basin: From Fold Kinematics to Hydrocarbon Systems, Lacombe, O., J. Lave, F. Roure and J. Verges (Eds.). Springer-Verlag, Berlin, pp: 491.

Jahani, S., J.P. Callot, J. Letouzey and D.F. de Lamotte, 2009. The eastern termination of the Zagros Fold-and-Thrust Belt, Iran: Structures, evolution and relationships between salt plugs, folding and faulting. Tectonics, Vol. 28. 10.1029/2008TC002418

James, G.A. and J.G. Wynd, 1965. Stratigraphic nomenclature of Iranian oil consortium agreement area. AAPG Bull., 49: 2182-2245.

Jenkyns, H.C., 1986. Pelagic Environments. In: Sedimentary Environments and Facies, Reading, H.G. (Ed.). 2nd Edn., Blackwell Scientific Publications, London, ISBN: 0-632-01223-4, pp: 343-397.

Kameliazan, E., H. Vazirimoghadam and H. Amiribakhtiar, 2000. Biostratigraphic study of the type section Gurpi formation in north of Domian Lali (Khoozestan). Proceedings of the 22nd Symposium on Geosciences, February 16, 2004, Tehran, Iran, pp: 124-125.

Katharina, P.N., 1981. New Maastrichtian and Paleocene calcareous nannofossils from Africa, Denmark, the USA and the Atlantic and some Paleocene lineages. Eclogae Geologicae Helvetiae, 74: 831-863.

Khalili, M., 1976. The biostratigraphic synthesis of the Bangestan Group in southwest Iran. Iranian Oil Operating Companies Report 1219.

Kheradpir, A., 1975. Stratigraphy of the Khami group in Southwest Iran. NIOC Report 1235, National Iranian Oil Company, Iran.

Meric, E., S. Ersoy and M. Gormus, 2001. Palaeogeographical distribution of the species of *Loftusia* (Foraminiferida) in the Tethyan ocean during the Maastrichtian (Late Cretaceous). Cretaceous Res., 22: 353-364.

Molinaro, M, J.C. Guezou, P. Leturmy, S.A. Eshraghi and D.F. de Lamotte, 2004. Th e origin of changes in structural style across the Bandar Abbas syntaxis, SE Zagros (Iran). Mar. Petrol. Geol., 21: 735-752.

Motiei, H., 1994. Geology of Iran: Stratigraphy of Zagros. Geological Survey of Iran Publications, Iran, pp: 197-201, 303-307.

Murris, R.J., 1980. Middle East: Stratigraphic evolution and oil habitat. AAPG Bull., 64: 597-618.

Piryaei, A.R., J.J.G. Reijmer, F.S.P. van Buchem, M. Yazdimoghadam, J. Sadouni and T. Danelian, 2010. The Influence of Late Cretaceous Tectonic Processes on Sedimentation Patterns Along the Northeastern Arabian Plate Margin (Fars Province, SW Iran). In: Tectonic and Stratigraphic Evolution of Zagros and Makran During the Mesozoic-Cenozoic, Leturmy, P. and C. Robin (Eds.). Geological Society of London, London, UK., ISBN: 9781862392939.

Piryaei, A., J.J.G. Reijmer, J. Borgomano and F.S.P. van Buchem, 2011. Late Cretaceous tectonic and sedimentary evolution of the Bandar Abbas area, Fars region, southern Iran. J. Petroleum Geol., 34: 157-180.

Robertson, A.H.F. and M.P. Searle, 1990. The Geology and Tectonics of the Oman Region. In: The Geology an Tectonics of the Oman Region, Robertso, A.H.F., M.P. Searle and A.C. Ries (Eds.). Geological Society of London, USA., pp: 285-306.

Scott, B., 1981. The Eurasian-Arabian and African continental margin from Iran to Greece. J. Geol. Soc., 138: 719-733.

Setudehnia, A., 1978. The Mesozoic sequence in Southwest Iran and Adjacent areas. J. Petrol. Geol., 1: 3-42.

Shakib, S.S., 1994. Paleoenvironmental and Biostratigraphic Significance of Foraminiferal Associations from the Early Cretaceous Sediments of Southwest Iran. In: Micropaleontology and Hydrocarbon Exploration in the Middle East, Simmons, M.D. (Ed.). Chapman and Hall, London, UK., pp: 127-150.

Sharland, P.R., R. Archer, D.M. Casey, R.B. Davies and S.H. Hall *et al.*, 2001. Arabian Plate Sequence Stratigraphy. Gulf PetroLink, Manama, Bahrain, pp: 371-384.

Sherkati, S. and J. Letouzey, 2004. Variation of structural style and basin evolution in the central Zagros (Izeh zone and Dezful Embayment), Iran. Mar. Pet. Geol., 21: 535-554.

Smit, J., J.P. Burg, A. Dolati and D. Sokoutis, 2010. Effects of mass waste events on thrust wedges: Analogue experiments and application to the Makran accretionary wedge. Tectonics, Vol. 29. 10.1029/2009TC002526

Taghavi, A.A., A. Mork and E. Kazemzadeh, 2007. Flow unit classification for geological modelling of a heterogeneous carbonate reservoir: Cretaceous Sarvak Formation, Dehluran field, SW Iran. J. Petroleum Geol., 30: 129-146.

Van Buchem, F.S.P., P. Razin, P.W. Homewood, J.M. Philip and G.P. Platel *et al.*, 1996. High resolution sequence stratigraphy of the Natih Formation (Cenomanian-Turonian) in Northern Oman: Distribution of source rocks and reservoir facies. GeoArabia, 1: 65-91.

Van Buchem, F.S.P., J. Letouzey, F. Gaumet, J.L. Rudkiewicz and J.M. Mengus *et al.*, 2001. The petroleum systems of the Dezful embayment and Northern Fars (South-West Iran). NIOC-IFP Joint Study Research Project, No. 55.729-1, National Iranian Oil Company (NIOC) Internal Report.

Van Buchem, F.S.P., D. Baghbani, L.G. Bulot, M. Caron and F. Gaumet *et al.*, 2006. Aptian organic-rich intrashelf basin creation in the Dezful embayment (Kazhdumi and Dariyan formations, Southwest Iran). Proceedings of the AAPG Annual Meeting, April 9-12, 2006, Houston, TX., USA.

Zambetakis-Lekkas, A. and A. Kemeridou, 2006. New data on the palaeobiogeography of *Loftusia* genus (Foraminiferida). An *in situ* presence of the genus in Eastern Greece (Boeotia). Comptes Rendus Geosci., 338: 632-640.