Biostratigraphy and Sequence Stratigraphy of the Gurpi Formation at Deh Dasht Area, Zagros Basin, SW Iran

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Abstract: A rich assemblage of planktonic foraminifera has been studied from an outcrop of the Gurpi Formation, the hydrocarbon source rock in the southwest Iran, Deh Dasht area (Kuh-e Siah anticline). Based on the distribution of the planktonic foraminifera, eight biozones have been recognized that included: Dicarinella concavata Interval Zone (Earliest Santonian), Dicarinella asymetrica Total Range Zone (Santonian to Earliest Campanian), Globotruncanita elevata Partial Range Zone (Early Campanian), Globotruncanina ventricosa Interval Zone (Middle to Late Campanian), Radotruncanina calcurata Total Range Zone (Late Campanian), Globotruncanella havanensis Partial Range Zone (Late Campanian), Globotruncanella aegyptiaca Interval Zone (Late to latest Campanian), Gansserina gansseri Interval Zone (Latest Campanian to Early Maastrichtian). These biozones indicate that the Gurpi Formation deposited during the Early Santonian- Early Maastrichtian. These biozones are compared to the most standard biozones defined in Tethysian domain. Based on distribution of morphotype groups of planktonic foraminifera, planktonic to benthic ratio (P/B) and content of carbonate, nine third-order sequences are recognized.

Key words: Planktonic foraminifera, biozones, Santonian, morphotype groups, sequence stratigraphy

1 Introduction

In general, the sedimentary record shows that the Late Cretaceous represents a period of major change in the area of the present-day Zagros foreland basin (Kamal et al., 2011). This time period spanned the deposition of the Shiranish (Iraq), Gurpi (Iran), Aruma and Sinsimsa (Kuwait, Saudi Arabia, United Arab Emirates), and Fiqqa (United Arab Emirates, Oman) formations, and their regional equivalents (Ziegler, 2001). The Gurpi Formation is extended in Folded Zagros in Provinces Khuzestan, Lurestan and Fars. Interest in the study of the paleontology, stratigraphy, and sedimentary environment of the Gurpi Formation has been largely investigated by the exploration for oil and gas, because it constitutes the source rock for petroleum in the oil-rich southwest Iran.

The Gurpi Formation at the type section (49°13′47″ E, 32°26′50″N) is composed of 320 metres of grey to blue marl and shale beds and occasionally thin beds of argillaceous limestones (James and Wynd, 1965). The Formation overlies the Ilam Formation and is conformably overlain by the Pabdch Formation at the type section. Microfauna of the Gurpi Formation were studied by Jalali (1971), Kalantary (1976), Vaziri Moghaddam (2002), Ghasemi-Nejad et al. (2006), Darvishzad et al. (2007),Hadavi and Senemari (2010), Bieranvand and Ghasemi-Nejad (2013), Parvaneh-Nejad Shirazi et al. (2013) and Beiranvand et al. (2013, 2014). The main purpose of this research is to establish a sequence stratigraphic study of the Gurpi Formation based on study of planktonic foraminifera, planktonic to benthic ratio (P/B), percentage of morphotype groups and the carbonate content.

2 Geological Setting

Iran is located within the active convergence zone between the Arabian and Eurasian plates (Lacombe and Moutheureau, 2006). During the Palaeozoic, Iran, Turkey and the Arabian plate (which now has the Zagros belt situated along its northeastern border) together with Afghanistan and India, made up the long, very wide and stable passive margin of Gondwanaland bordering the Paleo-Tethys ocean to the north (Sepehr and Cosgrove, 2004). The NW–SE-trending Zagros orogeny, which is
part of the much larger Alpine–Himalayan orogenic system, extends some 2000 km from the East Anatolian fault in eastern Turkey to the Makran subduction in southern Iran (Mouthereau, 2011). This plate is bounded to the northeast by the Zagros Main Thrust Fault (ZMTF), to the northwest by the Dead Sea Fault Zone (DSFZ), to the southwest by the Red Sea rift margin, and in the southeast by the Indian Ocean passive margin (Heydari, 2008). The Main Zagros Reverse fault is a proposed suture zone between the Arabian plate and Eurasia (Mc Quarrie, 2004). The evolution of the Zagros orogen is summarized by Alavi (2004, 2007) as:

(1) subduction of the Neo-Tethyan oceanic plate beneath the Iranian lithospheric plates during Early to Late Cretaceous time, (2) emplacement (“obduction”) of a number of Neo-Tethyan oceanic slivers (ophiolites) over the Afro-Arabian passive continental margin in Late Cretaceous (Turonian to Campanian) time, and (3) collision of the Afro-Arabian continental lithosphere with the Iranian plates in Late Cretaceous and later times.

3 Study Area

The study area (Kuh-e Siah anticline) is located about 15 Km to the north of Deh-Dasht area. The section was chosen for their good exposure and low tectonic overprint.

The section was measured in detail at 30°54′31.86″ N and 50°36′38.80″ E (Fig. 1). At the study area, the thickness of the Gurpi Formation is 212 m. Lithologically, it consists of shale, shaly limestone, and shale with thin bedded limestone. This formation conformably overlies limestone of the Ilam Formation and is conformably overlain by the Pabdeh Formation.

Planktonic foraminiferal evidence indicates the presence of a hiatus between the Gurpi Formation and the overlying Pabdeh Formation.

This area is located at the Izeh Zone. The Izeh Zone lies across a sharp topographic break to the southwest of the High Zagros Fault. This Zone consists of a variety of structures of variable sizes and geometric characteristics (Sherkati et al., 2004). The boundary of the Izeh zone coincides with the Balarud, Kazerun, Mountain Front and High Zagros faults. The Izeh zone and Dezful Embayment are separated by the Mountain Front Fault (Ghabeshahi et al., 2010).

4 Material and Methods

One hundred and thirty-five samples were collected during a fieldtrip. The samples include limestones, and shales. Because it was very difficult to disaggregate the hard samples and process them with normal washing, thin sections were prepared to analyze the planktonic foraminifera.

About 100 g of each soft sample was processed. The samples were dried, soaked in hydrogen peroxide (10%). The disaggregated samples were washed through a 63 μm, 125 μm and 250 μm sieves. About 310 individuals were picked up for each sample in two size fractions (125–250 μm). The residue was distributed on a black picking tray and at least 310 specimens were picked, whenever possible.

Atlases of European Working Group on Cretaceous Planktonic Foraminifera by Robaszynski and Caron (1979), Robaszynski et al. (1984), Caron (1985), Premoli Silva and Sliter (1994) are the basis for the identifications in this study. In addition, Postuma (1971), Wonders (1979), Fleury (1980), O’zkan and Ko‘ylu‘og‘lu (1988), Sliter (1989), Robaszynski et al. (2000), Premoli Silva and Verga (2004) are useful references, as they include thin-

![Fig. 1. Location map of the studied area in Zagros region, southwest of Iran.](image-url)
section illustrations of planktonic foraminifera.

5 Planktonic Foraminifera Biozones of the Gurpi Formation

Planktonic foraminifera are abundant and diverse in most samples of the Gurpi Formation at the studied section. In this study 16 genera and 45 species of planktonic foraminifera were recognized (Figs. 2–4). The zonal scheme presented here consists of 8 zones on the basis of the stratigraphic distribution of planktonic foraminifera recognized in thin sections and isolated specimens (Fig. 5).

5.1 Dicarinella concavata Zone

The zone is defined as the interval from the first appearance datum (FAD) of Dicarinella concavata (Brotzen) to the FAD of Dicarinella asymetrica (Sigal).

The thickness of the biozone is 4 m. In the studied section, the Dicarinella concavata Zone is the oldest zone, and corresponds to the lower part of the Gurpi Formation. This interval Zone is characterized by a well-diversified planktonic foraminiferal species: Marginotruncana coronata (Bolli), Marginotruncana sigali (Reichel), Marginotruncana pseudolimneiana (Pessagno), Marginotruncana marginata (Reuss) and Dicarinella primitiva (Dalbiez). The Dicarinella concavata Interval Zone is Late Turonian to Earliest Santonian in age and has been described by (James and Wynd 1965; Robaszynski et al. 1984; Caron 1985; Sliter 1989; Robaszynski and Caron 1995; Premoli Silva and Verga 2004).

5.2 Dicarinella asymetrica Zone

This zone with thickness 44 m is defined by the total range of Dicarinella asymetrica and corresponds to the Early Santonian to Earliest Campanian (Robaszynski et al. 1984; Caron 1985; Sliter 1989; Robaszynski and Caron 1995; Robaszynski 1998; Premoli Silva and Sliter 1994, 1999; Robaszynski et al. 2000; Premoli Silva and Verga 2004). Other species identified in this interval include Dicarinella concavata (Brotzen), Macroglabigerinelloides ultramicros (Subbotina), Globotruncanopa lapparente (Brotzen), Archaeoglobigerina cretacea (d’Orbigny), Contusotruncanopa fornicata (Plummer), Globotruncanopa arca (Cushman), Globotruncanopa bulloides (Vogler), Globotruncanopa hili (Pessagno), Marginotruncanopa marginata (Reuss) and Marginotruncanopa sigali (Reichel).

5.3 Globotruncanopa elevata Zone

The Globotruncanopa elevata Partial Range Zone represents the stratigraphical interval with Globotruncanopa elevata between the last occurrence of all Dicarinella and the first occurrence of Globotruncanopa ventricosa and corresponds to the Early Campanian. This zone was recorded from Zagros (James and Wynd 1965) and Tethys (Caron 1985; Sliter 1989). This Zone is characterized by planktonic foraminiferal species: Globotruncanopa lapparente (Brotzen), Globotruncanopa hili (Pessagno), Archaeoglobigerina cretacea (d’Orbigny), Globotruncanopa arca (Cushman), Macroglabigerinelloides ultramicros (Subbotina), Globotruncanopa bulloides (Vogler), Contusotruncanopa fornicata (Plummer),— -- Muricohedbergella monmouthensis (Olsson), Marginotruncanopa coronata (Bolli), and Rugoglobigerina rugosa (Plummer). The thickness of the biozone is 16 m.

5.4 Globotruncanopa ventricosa Zone

This zone defines the interval from first occurrence of Globotruncanopa ventricosa at the base to the first occurrence of Radotruncanopa calcarata at the top and corresponds to the Middle to Late Campanian. This zone was recorded from Tethys (Caron 1985; Sliter 1989). The assemblage includes: Globotruncanopa hili (Pessagno), Archaeoglobigerina cretacea (d’Orbigny), Globotruncanopa arca (Cushman), Macroglabigerinelloides ultramicros (Subbotina), Globotruncanopa bulloides (Vogler), Radotruncanopa subspinosa (Pessagno), Contusotruncanopa fornicata (Plummer), Globotruncanopa elevata (Brotzen) and Ventilabrella (Brotzen). This biozone occurs in thickness of 14 meters of the Gurpi Formation.

5.5 Globotruncanopa calcarata Zone

This zone with thickness 12 m is defined by the total range of Globotruncanopa calcarata and corresponds to the Late Campanian. This zone described by Caron (1985) and Sliter (1989) from Tethys. The predominant planktonic foraminifer is: Archaeoglobigerina cretacea (d’Orbigny), Globotruncanopa arca (Cushman), Macroglabigerinelloides ultramicros (Subbotina), Globotruncanopa bulloides (Vogler), Contusotruncanopa fornicata (Plummer) and Globotruncanopa stuartiformis (Dalbiez).

5.6 Globotruncanopa havanensis Zone

The zone is defined as the interval from the last occurrence of Radotruncanopa calcarata to the first occurrence of Globotruncanopa aegyptica, and corresponds to the Late Campanian. This zone described by (Caron 1985) and (Sliter 1989) from Tethys. The predominant planktonic foraminifer are: Rugoglobigerina hexacameralata (Broenniman), Macroglabigerinelloides ultramicros (Subbotina), Globotruncanopa bulloides
Fig. 2. (1a-1c) spiral, peripheral and umbilical view of *Marginotruncana sinousa*. (2a-2c) spiral, peripheral and umbilical view of *Globotruncana hilli*. (3a-3c) spiral, peripheral and umbilical view of *Maricohedbergella holmdelensis*. (4a-4c) spiral, peripheral and umbilical view of *Marginotruncana marginata*. (5a-5c) spiral, peripheral and umbilical view of *Globotruncanca arca*. (6a-6c) spiral, peripheral and umbilical view of *Marginotruncana renzi*. (7a-7c) spiral, peripheral and umbilical view of *Dicarinella asymetrica*. (8a-8c) spiral, peripheral and umbilical view of *Dicarinella concavata*. (9a-9c) spiral, peripheral and umbilical view of *Dicarinella cf. concavata*. (10a-10c) spiral, peripheral and umbilical view of *Maricohedbergella silteri*. (11a-11c) spiral, peripheral and umbilical view of *Globotruncana cf. orientalis*. (12a-12c) spiral, peripheral and umbilical view of *Globotruncana cf. bulloides*. 
Fig. 3. (1a-1c) spiral, peripheral and umbilical view of Globotruncanina orientalis. (2a-2c) spiral, peripheral and umbilical view of Globotruncanita angulata. (3a-3c) spiral, peripheral and umbilical view of Globotruncanina mariei. (4a-4c) spiral, peripheral and umbilical view of Marginotruncanina paraconcavata. (5a-5c) spiral, peripheral and umbilical view of Gansserina gansseri. (6a-6c) spiral, peripheral and umbilical view of Globotruncanita stuarti. (7a-7c) spiral, peripheral and umbilical view of Contusotruncanina plummera. (8a-8c) Globotruncanina arca. (9a-9c) spiral, peripheral and umbilical view of Contusotruncanina patelliformis. (10a-10c) spiral, peripheral and umbilical view of Marginotruncanina cf. pseudolinneiana. (11a-11b) spiral and peripheral view of Contusotruncanina fornicata. (12a-12b) umbilical and peripheral view of Globotruncanina linneiana. (13a-13b) Heterohelix sp.
Fig. 5. Distribution and planktonic foraminiferal zonation of the Gupj Formation at Dahl Danfit area.
contusotruncanana fornicata (Plummer). The thickness of the biozone is 10 m.

5.7 Globotruncanana aegyptiaca Zone

The Globotruncanana aegyptiaca zone is defined as the interval from the first appearance of Globotruncanana aegyptiaca to the first appearance of Gansserina gansseri and corresponds to the Late to Latest Campanian. This zone described by (Caron 1985) and (Sliter 1989) from Tethys. The predominant planktonic foraminifera are: Rugoglobigerina rugosa (Plummer), Globotruncanana hillii (Pessagno), Heterohelix sp., Murichohedbergella sp., Globotruncanita stuartiformis (Dalbice), Globotruncanana falsostuwarti (Sigal), Contusotruncanana patelliformis (Gandolfi), Globotruncanita angulata (Tilev), Globotruncanana lineanea (d’Orbigny) and Globotruncanita stuarti (de Lapparent). This biozone occurs in thickness of 66 meters of the Gurpi Formation.

5.8 Gansserina gansseri Zone

This zone defined as the interval from the first appearance of Gansserina gansseri to the first appearance of Contusotruncanana contusa and Racemiguembelina fructicosa and corresponds to the Latest Campanian to Early Maastrichtian. This zone described by Caron (1985) and Sliter (1989) from Tethys. The predominant planktonic foraminifera are: Globotruncanana lapparenti (Brotzen), Contusotruncanana fornicata (Plummer), Globotruncanana arca (Cushman), Globotruncanana insignis (Gandolfi), Globotruncanana orientalis (El-Naggar) and Radotruncanana subspinosa (Pessagno). The Contusotruncanana contusa and Racemiguembelina fructicosa zone and Abathomphalus mayaroensis zone (Late Maastrichtian) are absent in this section in the Deb-Dasht area. The thickness of the biozone is 46 m.

6 Sequence Stratigraphy

The sea level changes in relatively deep waters are not easily identified based on benthic foraminifera or lithology, because the former are rare or absent and major lithological changes are generally absent. This appears to be the case for the Gurpi Formation (Late Cretaceous) at Zagros Basin, which was deposited at depths ranging from 200–500 m. The absence of large benthic foraminifera does not permit any evaluation of sea-level changes based on these indices. However, the planktonic morphgroups, CaCO3 content and P/B ratio reveal major fluctuations. One of the most commonly used faunal indicators for paleodepths and sea level changes in the open marine water are planktonic foraminifera which live abundantly in the open marine water. Planktonic foraminifera are generally used to infer palaeodepths open marine water and consequently to infer relative sea-level changes. The morphotypes and inferred depth distribution of planktonic foraminifera used here follow Hart and Baily (1979), Hart (1980a, 1980b) and Wonders (1980) and are as follow: 1- Globular, unkeeled (e.g. Murichohedbergella spp.), shallow water (0–50 m). 2- Peripheral margin subrounded, unkeeled with ornamentation (e.g. Rugoglobigerina rugosa), intermediate-water (50–100 m). 3- Keeled, biconvex (e.g. Globotruncanita stuarti), deep-water (100 m). 4- Keeled, planoc convex, deepest water (e.g. Gansserina gansseri).

Based on this study, we have grouped the planktonic foraminifera into shallow water faunas, middle water faunas and deep water faunas. We therefore used this subset of the planktonic foraminifera to infer sea-level change. The combined results from planktonic morphgroups, CaCO3 content and P/B ratio may thus provide the best results for the interpretation of sea-level fluctuations during the late Cretaceous. In the study area, on the basis of distribution of planktonic foraminifera morphgroups, P/B ratio, and CaCO3 content, nine depositional sequences have been recognized (Fig. 6).

6.1 Sequence 1

This sequence is Early Santonian in age, belonging to the Dicarinella concavata Zone. This sequence includes the upper part of the IIm Formation and the lower part of the Gurpi Formation. The maximum flooding surface (mfs) coincides with the boundary between the IIm and Gurpi formations. Packstone (sample No.8) with abundant morphotypes 3 and 4 and glauconit represent deep-water facies; this is, therefore, interpreted as the mfs. In addition, CaCO3 content is maximum in sample No.8. Moreover, the percentage of morphotypes 3 and 4 and the P/B ratio decrease from sample No. 9.5 to the top of the sequence, which indicate the HST. The sequence boundary (SB) is characterized by maximum decrease in P/B ratio and the percentage of morphotypes 3 and 4 in sample No. 14 (Fig. 7).

6.2 Sequence 2

The depositional sequence 2 formed during the Early Santonian-Middle Santonian.

TST occurs in the Dicarinella asymetrica Zone. The thickness of this sequence is around 8 m. The TST of this sequence is characterized by increasing in percentage of morphotypes 3 and 4, CaCO3 content, and P/B ratio. CaCO3 content, P/B ratio and percentage of morphotypes 3 and 4 are maximum in sample No. 19. Such characteristics with high value of phosphate indicate low sedimentation rate and mfs. The HST is composed of wackestone in which, from bottom to top, percentage of
Fig. 6. Depositional sequence of this section and correlation with Haq and Schutter, (2008).
morphotypes 3 and 4 decreases. The maximum decrease of percentage of morphotypes 3 and 4, CaCO$_3$ content and P/B ratio in sample No. 22 indicates the SB. This sequence boundary seems to correlate with the sequence boundary San2 of Haq and Schutter (2008) (Fig. 8).

6.3 Sequence 3
This sequence is 22 m thick and is Middle-Late Santonian in age. Based on planktonic foraminifera, this part of succession occurs within the *Dicarinella asemetrica* Zone.

The lower part of sequence 3 is characterized by gradual increasing of percentage of morphotypes 3 and 4, CaCO$_3$ content, and P/B ratio, interpreted as TST. The overlying packstone (sample No.28) with high ratio of planktonic to benthic faunal assemblages, abundance of morphotypes 3 and 4, and high value of CaCO$_3$ reflects a mfs, and the beginning of deposition of a HST. General decreasing trend of the CaCO$_3$ content, P/B and morphotypes 3 and 4 curves represent the HST. The sample No.44 contains a minimum percentage of morphotypes 3 and 4, low values of P/B ratio and CaCO$_3$ content, therefore, interpreted as the SB. This sequence boundary appears to correlate with the sequence boundary San3 of Haq and Schutter (2008) (Fig. 9).

6.4 Sequence 4
The thickness of this sequence is around 10 m. It is Late Santonian-Early Campanian in age, belonging to the *Dicarinella asemetrica* Zone.

The lower part of sequence is composed of wackestone with a predominance of morphotypes 3 and 4 is substituted by packstone containing abundant morphotype 2. Again, the lower parts are interpreted as TST and the upper parts as HST. The faunal change across the maximum flooding surface is gradual. Mfs indicates low-energy conditions, maximum value of CaCO$_3$ content, and a high ratio of planktonic to benthic faunal assemblages.

The maximum decrease of percentage of morphotypes 3 and 4, CaCO$_3$ content and P/B ratio in sample No. 54 indicates the SB. This sequence boundary seems to correlate with the sequence boundary Cam1 of Haq and Schutter (2008) (Fig. 10).

6.5 Sequence 5
The depositional sequence 5 formed during the Early Campanian transgression. The thickness of this sequence is around 14 m. Based on planktonic foraminifera, this sequence occurs within the *Globotruncanita elevata* Zone.

This sequence starts with packstone, containing a rich assemblage of morphotypes 3 and 4 of planktonic foraminifera. The upper part of the sequence is composed of wackestone in which, from bottom to top, percentage of morphotypes 3 and 4 decreases. Thus, we observe in the basal part predominance of morphotypes 3 and 4, and in the upper part a gradual shift from morphotypes 3 and 4 towards morphotypes 2 and 1. The lower part is interpreted as a TST and the upper part as a HST. The SB is characterized by maximum decrease in P/B ratio and the percentage of morphotypes 3 and 4 in sample No. 68. This sequence boundary seems to correlate with the sequence boundary Cam6 of Haq and Schutter (2008) (Fig. 11).

6.6 Sequence 6
The thickness of this sequence is around 8 m. It is early Middle Campanian in age, belonging to the basal part of *Globotruncanina ventricosa* Zone. The lower part of sequence 3 composed of wackestone with a predominance of morphotypes 3 and 4, CaCO$_3$ content and P/B ratio, is substituted by packstone containing abundant morphotypes 1 and 2, which its value of CaCO$_3$ content and P/B ratio have been decreased. Again, the lower parts are interpreted as TST and the upper parts as HST. The faunal change across the maximum flooding surface is gradual. The maximum decrease of percentage of morphotypes 3 and 4, CaCO$_3$ content and P/B ratio in sample No. 76 indicates the SB. This sequence boundary seems to correlate with the sequence boundary Cam 7 of Haq and Schutter (2008) (Fig. 12).

6.7 Sequence 7
In the lower part of this sequence, the values of the percentage of morphotypes 3 and 4, P/B ratio, and CaCO$_3$ content increase from the bottom to the top. While in the upper part of the succession the values of all above mentioned parameters decrease. The lower part is interpreted as a TST and the upper part as a HST. The sample No.82 (packstone) contains a rich percentage of morphotypes 3 and 4, high values of P/B ratio and CaCO$_3$ content, therefore, interpreted as the mfs. The SB is characterized by maximum decrease in P/B ratio and the percentage of morphotypes 3 and 4 in sample No. 86. This sequence boundary appears to correlate with the sequence boundary Cam 8 of Haq and Schutter (2008).

6.8 Sequence 8
The depositional sequence 8 formed during the Late Campanian transgression (*Radotruncanina calcarea* and *Globotruncanina aegyptica* zones). The thickness of this sequence is around 43 m. The lower part of sequence 8 is characterized by gradual increasing of percentage of morphotypes 3 and 4, CaCO$_3$ content, and P/B ratio, interpreted as TST. Packstone (sample No.113.5) with abundant morphotypes 3 and 4, high value of CaCO$_3$,
Fig. 7. Increasing in percentage of morphotypes 3 and 4 and glauconit in sample No. 8.

Fig. 8. Increasing in percentage of morphotypes 3 and 4 and glauconit in sample No. 19.

Fig. 9. Increasing in percentage of morphotypes 3 and 4 and glauconit in sample No. 28.

glaucosit and phosphate represent deep-water facies; this is, therefore, interpreted as the mfs. General decreasing trend of the CaCO₃ content, P/B and morphotypes 3 and 4 curves represent of HST.

The SB is characterized by maximum decrease in P/B ratio and the percentage of morphotypes 3 and 4 in sample No. 129. This sequence boundary seems to correlate with the sequence boundary Cam9 of Haq and Schutter (2008) (Fig. 13).
6.9 Sequence 9

The thickness of this sequence is around 91 m. It is Late Campanian-Middle Maastrichtian in age, belonging to the *Globotruncana aegyptica* and *Gansserina gansseri* zones. The TST of this sequence is characterized by increasing in percentage of morphotypes 3 and 4, CaCO₃ content, and P/B ratio. CaCO₃ content, P/B ratio and percentage of morphotypes 3 and 4 are maximum in sample No. 196. Such characteristics with high value of phosphate and gloconit indicate low sedimentation rate and mfs. The
upper boundary in sequence 9 is sharp and clearly defined as type I of sequence boundary. This sequence is overlain by the Pabdeh Formation (Fig. 14). Based on planktonic foraminifera data, the base of the Pabdeh Formation (Morzonella angulata igerina pusilla Zone) has been assigned to late Paleocene. The planktonic foraminiferal assemblages of the Constantruncana contusa, Racemiguembelina fructicosa Zone and Abathomphalus mayaroensis Zone (Late Maastrichtian) are absent in this section. Therefore, between the Gurpi Formation and the overlying Pabdeh Formation exist a hiatus.

Based on biostratigraphy data, the Gurpi Formation in the Izeh Zone (Danial section) is late Campanian–Selandian in age. Moreover, it represents a continuous Cretaceous–Paleogene succession which include nine depositional sequences (Beiranvand and Ghasemi-Nejad 2013, Beiranvand et al., 2014). The sedimentary succession reflects deposition in outer neritic environment and shows no any tectonic activities during the Maastrichtian – Paleocene (Beiranvand and Ghasemi-Nejad 2013, Beiranvand et al., 2014). In the study area hiatus between K/T may have been related to compressional tectonics as the Maastrichtian had been the closure time for the Arabo-African and Iranian plates. Eustatic sea level changes may have had a secondary effect in the mentioned hiatus.

7 Conclusion

Based on planktonic foraminifera, eight biostratigraphic zones are proposed for the Early Santonian to Early Maastrichtian interval in the southwest Iran, Deh Dasht area (Kuh-e Siah anticline). The following zones are proposed: Dicarinella concavata Interval Zone (Earliest Santonian), Dicarinella asymmetrica Total Range Zone (Santonian to Earliest Campanian), Globotruncanita elevata Partial Range Zone (Early Campanian), Globotruncanina ventricosa Interval Zone (Middle to Late Campanian), Radoitrunca calcarata Total Range Zone (Late Campanian), Globotruncanella havanaensis Partial Range Zone (Late Campanian), Globotruncanina aegyptiaca
Interval Zone (Late to latest Campanian), Gansserina gansseri Interval Zone (Latest Campanian to Early Maastrichtian). Nine third-order sequences are identified, on the basis of content of carbonate, planktonic to benthic ratio (P/B) and the distribution of morphotype groups of the planktonic foraminifers.

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