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Microfacies and Sedimentary Environments of Gurpi and Pabdeh Formations in Southwest of Iran

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Abstract: Problem statement: The Upper Cretaceous Gurpi and lower Tertiary Pabdeh formations as units of folded Zagros Zone were studied in three different regions (Tang-e-Abolhiat, Tang-e-Zanjiran and Maharloo) in Fars Province, Iran. **Approach:** Gurpi formation consisted of thin to medium sized layers of gray marl and marlstone interbedded with thin layers of argillaceous limestone and shale. The dominant microfacies in this formation biomicrite; Index species of *Globotruncana* give the age of the Formation from lower companion to upper Maastrichtian. Pabdeh formation consisted of bluish gray, thin to medium sized layers of shale and marl and interlayers of argillaceous limestones with purple shales and thin cherty beds at lower part, dark gray shales and marls with interlayers of argillaceous limestones in the middle andalternative layers of thinly bedded argillaceous limestone, shale and marl at the upper part. The dominant microfacies are biomicrite. Index species of *Globorotalia* and *Hantkenina* give the age of formation from upper Paleocene to Eocene. **Results:** The sedimentary environment of both formations is a bathymetrical carbonate floored basin (deep shelf or basin margin) which had deposited its facies in transgressive stage. The contact between the two formations is of disconformity type. In Tang-e-Abolhiat it lies at the base of purple shale. In this region and also in Tang-e-Zanjiran and Maharloo, in addition to recognition of *Globorotalia velascoensis*, which was attributed to lower part of the Pabdeh formation, a glauconitic-phosphatic bed separates the two formations. **Conclusion/Recommendations:** The boundary between Gurpi and Pabdeh formations represented a non-depositional period from the late Maastrichtian to the end of early Paleocene.

Key words: Folded zagros zone, Fars province, mesozoic-cenozoic boundary

INTRODUCTION

The main scope of this study is to study the litho- and bio-facies of Upper Cretaceous Gurpi and Paleocene-Eocene Pabdeh formations and hence identification of their sedimentary environments in three different regions (north-east flank of Ghareh mountain in south of Maharloo lake; Tang-e-Zanjiran, about 35 km north of Firoozabad; Tang-e-Abolhiat, some 75 km west of Shiraz to Kazeroon) in Fars Province in Iran (Fig. 1). Tectonically the area is part of a foreland basin filled dominantly with a thick sedimentary sequence of clastic and carbonate compositions.

The three mentioned regions show remarkable outcrops of the two formations (Gurpi and Pabdeh; Fig. 2 and 3), which is due to structural impressions affected there and also petrological nature of the formations. The effect of these two factors has formed special morphology which appears throughout the outcrops. High and elongated NW-SE trends anticlines, long strike faults (which have cut the anticlines longitudinally and opened them laterally by erosion), short faults (which cut them widthwise) and lineaments which are of structural and stratigraphical origins are the similar structural elements in the regions.

Fig. 1: Location map of the studied areas

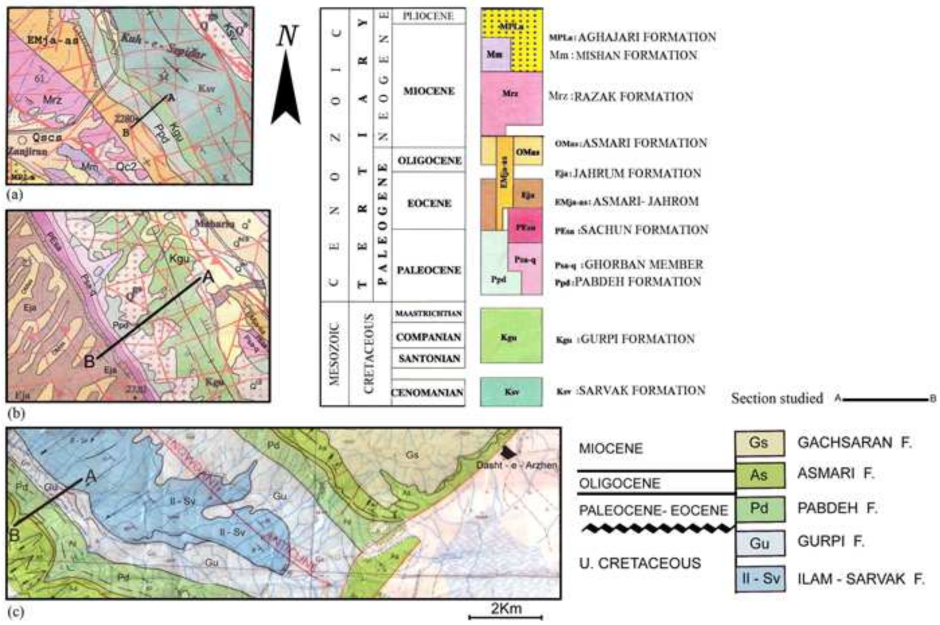

Fig. 2: Geological map of the studied areas: (a): Tang-e-Zanjiran[2]; (b): Maharloo[1]; (c): Tang-e-Abolhayat[11]

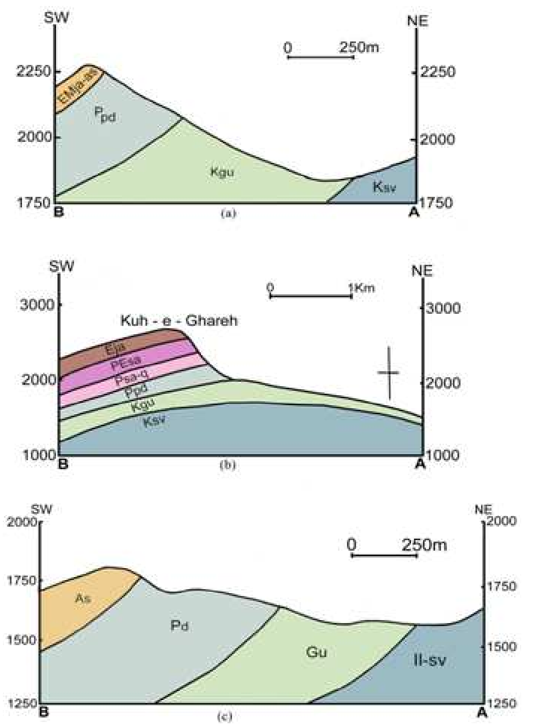

Fig. 3: Geological cross sections of the studied areas: (a): Tang-e-Zanjiran; (b): Maharloo; (c): Tang-e-Abolhayat

The two formations, due to the low stability of their rock deposits (marl, shale, argillaceous limestone), exhibit a low morphology and more or less change in thicknesses. Since the upper and lower parts of these formations are of hard carbonate rocks of Asmari-Jahrum and Sarvak formations[9,15], differential erosion has caused deep strike valleys due to the alternation of hard limestones and soft marls and dense branching drainage systems in the latter; the similar morphological elements are seen in all mentioned regions.

MATERIALS AND METHODS

As mentioned above, field work was concentrated in three different regions. Three sections were measured in detail crossing the trend of anticline flanks. Samples were taken almost every 10 m and in addition to that, sampling was based on facies variations. Approximately 250 thin sections were studied, in order to identify relevant microfacies.

RESULTS

Microfacies: Gurpi Formation, that with a thickness of about 500 m at Tang-e-Zanjiran and 450 m at Tang-e-Abolhiat disconformably overlies Sarvak Formation includes thin to medium bedded bluish gray marl and marlstone associated with thin interlayers of argillaceous cream limestones. 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. Thin sections study of provided samples shows dominantly biomicrite to biopelmicrite (wackstone) and sometimes micrite[4,8] all argillaceous to some extent. Small and rounded mirosparitic intraclasts and sparry calcite cement that fill all foraminiferal chambers are dominant features seen in thin sections. Iron oxides (opaque), glauconite and phosphate especially at upper parts, radiolarian cherts and destroyed bitumen all are seen in sparse. Microfossils are dominantly planktonic (pelagic) foraminifera which show 5 biozones (Fig. 4):

- *Globotruncana elevata* zone; associated microfossils are *G. bulloides*, *Hedbergella* and *Heterohelix*. This biozone is seen at lower part of the Formation in the three regions and the age is Lower Companian
- *Globotruncana ventricosa* zone; associated microfossils are *G. Bulloides*, *G. Arca*, *G. Lapparenti*, *G. Falsostuarti*, *Hedbergella* and *Heterohelix* (plate1). This biozone is observed at Maharloo and Tang-e-Abolhiat and the age is Lower Companian to lower part of Upper Companion
- *Globotruncana calcarata* zone; associated microfossils are *G. Lapparenti*, *G. elevata*, *G.bulloides*, *G. Ventricosa*, *G. Arca*, *G. Stuarti*, *G. Falsostuarti*, *G. Linniana*, *Hedbergella* and *Heterohelix* (plate 2). This biozone is observed at Tang-e-Abolhiat and Maharloo and the age is Upper Companian
- *Globotruncana stuarti* zone; associated microfossils are *G. bulloides*, *G. Conica*, *G. Lapparenti*, *G. falsostuarti*, *Hedbergella* and *Heterohelix* (plate 3). This biozone is seen in all of the three regions and the age is Lower Maastrichtian
- *Globotruncana gansseri* zone; associated microfossils are *G. conica*, *G. falsostuarti*, *G. gagnebini* and *Hedbergella* (plate 4). This biozone is observed at Tang-e-Abolhiat and Maharloo and the age is Middle to Upper Maastrichtian

Pabdeh Formation, with a thickness of 300 m at Tang-e-Zanjiran and 500 m at Tang-e-Abolhiat, disconformably overlies Gurpi Formation and consists of thin to medium bedded bluish gray shale and marl and interlayers of argillaceous limestones. There exist also some beds of purple to bluish sandy shale with a thickness of about 6 m overlied by thin layers of nodular and lenticular chert (Fig. 5) and occasionally silty-sandy limestones interlayered with marls at the base of the Formation at Tang-e-Abolhiat.

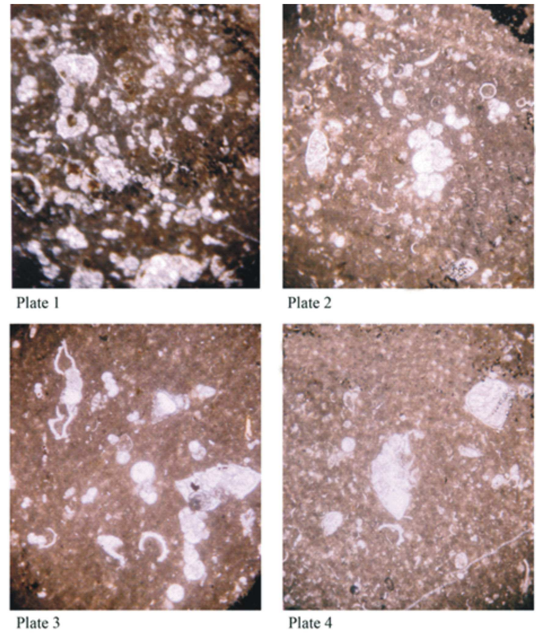

Fig. 4: Plates 1-4: Argilaceous biomicrite, with rounded and small microsparitic intraclast and sparite ciment filled foraminiferal (*Globotruncana*) chambers. $\times 30$

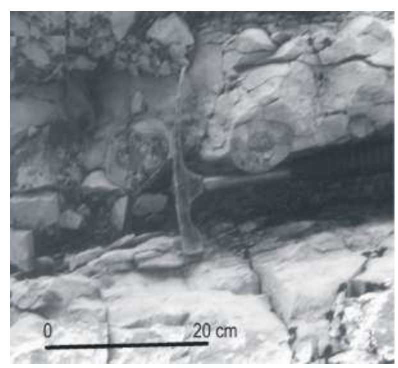

Fig. 5: A bed of layered and lenticular cherts at the base of Pabdeh formation

Dark gray shale and marl with interlayers of thin bedded argillaceous limestones and alternative layers of gray thin to medium bedded argillaceous limestones, shale and marl at lower part which gradually change to med. to thick bedded limestones at middle and upper parts form the whole lithofacies of the formation. Thin sections study of the provided samples, as those of Gurpi Formation, shows biomicrite and pelbiomicrite (wackstone) and in parts micrite (mudstone) with scattered small rounded microsparitic intraclasts and sparry calcite cement filled all foraminiferal chambers.

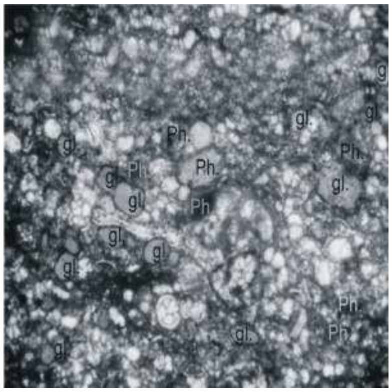

Fig. 6: Phosphatic and glauconitic marl at the base of the Pabdeh Formation × 30. Phosphate: Ph. glauconite: Gl

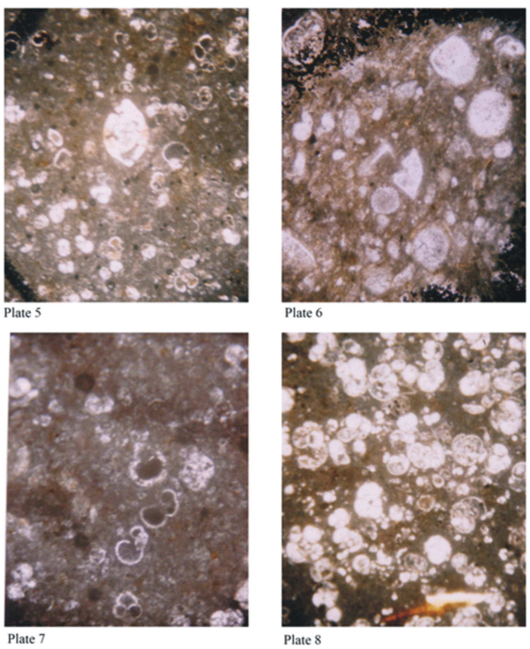

Fig. 7: Argilaceous biomicrite, with rounded and small microsparitic intraclast and sparite ciment (occ. Micrite filled foraminiferal (*Globorotalia*-plates 5-7 and Globigerina-plate 8) chambers. × 30

Glauconite mineral and phosphate material at lower parts (Fig. 6) and some fine quartz crystals (probably of radiolarian origin), which fills the chambers or rests irregularly, are the dominant features seen in thin sections.

Microscopic studies show 4 biozones in this formation in the regions studied (Fig. 7):

- *Globrotalia velascoensis* zone; Upper Paleocene
- *Globorotalia aragonensis* zone; Lower Eocene (plates 5 and 6)
- *Globorotalia spinolusa* zone; Middle Eocene
- *Globorotalia centralis-Hantkenina* assemblage zone; upper Eocene (plate 7)

Other microfossils such as Globigerina (plate 8) are observed likewise.

Pabdeh Formation has an interfingering relationship with Jahrum Formation and underlies by it (at Tang-e-Zanjiran), Asmari Formation (at Tang-e-Abolhiat) andGhorban member of Sachun Formation (at Maharloo).

Gurpi and Pabdeh formations boundary: The contact between Gurpi and Pabdeh formations is of disconformity type. Considering lithological similarity of both formations, determination of this unconformity from field observations is not possible and it is done by means of microscopic studies and microfossil recognition. The contact between the two formations, at Tang-e-Abolhiat, rests at the base of purple shale. At Maharloo and Tang-e-Zanjiran, in addition to the recognition of *Globotruncana velascoensis* which is referred to the lower part of Pabdeh Formation, a bed of glauconitic marl is seen in this part. This bed, which distincts the two formations (Pabdeh and Gurpi), shows a hiatus from late Maastrichtian to the end of Early Paleocene.

Sedimentary environments: The interpretation of depositional processes and sedimentary environments is usually done by their lithofacies and biofacies and, in particular, their microfacies. The following microfacies criteria, which are observed in microscopic examination of both formations, show a deep marine environment[5,7,10,13,14]. Micrite dominates; it is homogenous and microcrystalline and accompanies with planktonic microfossils (an indication of low energy environment); sparry calcite cement fills all microfossils chambers; pelloids usually exist in micrite and biomicrite (fecal pellets occur in micrite); microsparitic intraclasts, due to weak sea currents or downward slump, exist (intraclasts are indication of sea floor erosion and sedimentation at down slope); calcilutite with fine bioclasts and pelagic mudstone; glauconite accumulates beneath the discontinuity surface (of course, it is not an indication of deep marine; nowadays, glauconite is found in depths of 30-700 m); coloured layers (due to the enrichment of ferromanganese materials at sedimentary discontinuity surfaces); chert, which is an indication of deep marine environment, in the form of nodular and layered; frequent alternative layers of limestone and marl.

A marine environment with above-mentioned characteristics is also called pelagic environment[3]. The interpretation of ancient sediments as pelagic relies primarily on the recognition of included planktonic organisms. With Tertiary and Upper Mesozoic sediments, such as the formations being studied recognition of planktonic components is relatively easy, since comparable faunas and floras may survive to the recent. Crucial to any study of pelagic sediments on land is an investigation of the nature of the basement on which they were deposited.

Epeiric or epicontinental pelagic facies, since they are deposited on stable cratons during a relative high stand of sea level will, however, remain largely undeformed. From a tectonic point of view they have the greatest preservation potential of all pelagic sediments, while ancient pelagic facies laid down in ocean will have been or will ultimately be subducted[10].

Marl, the dominant rock that makes up the two formations, clearly marks a phase of deepening and transgression as pelagic conditions spreading over this part of the country. Gurpi marls, thus, may be attributed to Upper Mesozoic transgressions. Chalks deposited during the Late Cretaceous in the Middle East and other places have been attributed to these transgressions[10]. Glauconite is formed by replacement of clays, skeletal carbonates and fecal pellets [6]. The presence of bitumen suggests that parts of the environment were at times in contact with anoxic waters.

DISCUSSION

In all three regions, the subsidence of the basin started at Companion and the sedimentation rate was in accordant with the rate of subsidence which is synchronous with global sea level rise and its transgression which caused a thick accumulation of deep marine marl and shale [12]. The Late Cretaceous marl may be most simply related to the spectacular end-Mesozoic transgression which flooded cratonic areas. Phyto-and zoo- plankton could thus flourish and in the absence of clastics, produced pelagic sediments. Epeiric seas are likely to be fertile and support abundant plankton since areas close to continents are usually well supplied with nutrients.

General regression at the end of Maastrichtian (due to Laramid orogeny) and depth decreasing led to impression of an erosional phase at the boundary of Mesozoic-Cenozoic (Pabdeh-Gurpi disconformity and Lower Paleocene hiatus). The purple (sandy) shales and cherts, at the base of Pabdeh Formation, are referred to this depth decreasing. Deposition of Pabdeh marl and shale is an indication of redeepening of sea from upper Paleocene. The lithofacies similarity of Pabdeh and Gurpi formations indicates a similarity in conditions and sedimentary environments.

CONCLUSION

The Upper Cretaceous Gurpi and Lower Tertiary Pabdeh formations, as units of Folded Zagros Zone, consist of a series of sedimentary rocks of which marl is dominated. The dominant microfacies of both formations is biomicrite (wackstone). Gurpi Formation consists of 5 biozones of *Globotruncana* and Pabdeh Formation consists of 4 biozones of *Globorotalia*. Both formations show a deep marine environment (pelagic environment).

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