



# Investigation of the Sequence Stratigraphy of the Gurpi Formation in Abadan Plain (wells A, B and C)

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## ARTICLE INFO

### Article history:

Received: 14 March 2015;

Received in revised form:

20 April 2015;

Accepted: 23 April 2015;

### Keywords

Microfacies,  
Abadan Plain,  
Sequence Stratigraphy,  
Gurpi Formation.

## ABSTRACT

Gurpi formation (Companian-Maestrichtian) is one of the importance formations that include as a Cap rock for reservoirs Sarvak in south west of Iran. Assessment of Gurpi formation facies in the wells A,B and C lead to know ten microfacies that related to facies belts of middle ramp and outer ramp. Outer ramp's facies are allocate the maximum thickness in these wells. Field studies and assessment of vertical facies changes in sequence lead to know main surface of sequence in studied area. This formation have been formed of two sequences (3<sup>rd</sup> cycles). Sequences are separated by sequence boundaries type of 1 and 2 (SB<sub>1</sub> and SB<sub>2</sub>).

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## Introduction

Zagros basin is one of the important structural geology in Iran. This zone is located in the West and South-West of Iran (Darvishzadeh, 1370). Lack of igneous activity and existence of numerous source rocks and rich organic matter, porosity and permeability of reservoir rocks with suitable cap rocks, supplying unique situation for production and accumulation of hydrocarbon until this area became the most oil-rich sedimentary basin in the word (Afshar harb,1380).

Gurpi formation (Companian-Maestrichtian) is important as a cap rock in this area. The studied area is located in north of Dezfol that is part of folded zagros(Fig.1). Gurpi formation in studied area have two upper and lower parts.Tarbur Tang is between these two. Gurpi formation in this area consist of marl and gray shale to blue with intercalation of thin clayey limestone.

The lower Grup formation is in the well A (110 meters),well B (120 meters),and well C (130.5 meters) in thick. This part includes gray limestone, sometimes is clayey and silty, light gray marl that at the end change to alternate of gray limestone and light brown clayey and thin gray shale layer tend to green. The thickness of the upper Gurpi formation is in well A (77 meters), well B (72 meters) and well C(102.5 meters) in thick that start mainly of buff-brown limestone and somewhat Glauconite and changed to thick gray marl layer to light brown soft silt and alternate of clayey gray limestone. The thickness of the upper and lower Gurpi formation generally increases towards the South of the study area(Fig.2). In the last years, many studies have been done on Gurpi formation (e.g:Gharib,1375; Norozi,1380; Cameli Arzan 1382; Hooseini,1385; Hoshyar 1386 and Hemat,1387) can be noted. The purpose of this research is assessment of sequence stratigraphy of the Gurpi formation, facies classification, interpretation and analysis of those that how to spread this formation were evaluated with correlation these wells with each other.

## Geological setting

The Study area is located in north of Dezfol that is part of Folded Zagros(Alavi,1994). The type section of the Gurpi formation has been measured in pabedeh in south west of Gurpi mountain in north of Lali and Masjed soleyman (Aghanabati, 1383). Gurpi formation in type section has located with a local unconformably over Ilam formation. This contact with weathered zone includes Iron compounds. The Upper contact of this formation in type section is pabdeh formation. This contact in Farse and some part of Khozestan comes with unconformably but in Lorestan is whitout discontinuity In south of Dezfol Embayment the upper contact of Gurpi formation is determined with thin layer of conglomerate and gloconite in under a cherty and phosphatic layer (Motiee,1383). Gurpi formation has developed in south and southwest of Iran. This formation in studied area has been located gradually over Ilam formation and the Pabdeh formation unconformably overlies the Gurpi formation.

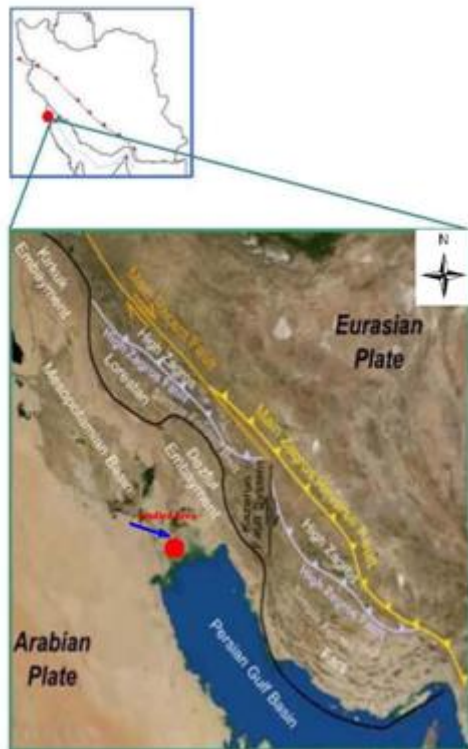
## Method of study

Assessment of field study 504 Tinsection were prepared from wells A,B and C. This tinsections were investigated from different things such as rate, kind of skeletal and non-skeletal parts and textual characteristics. The facies have been named by the classification of Dunham, 1962. In classification and interpretation have been used (e.g., Wilson 1975 and Flugel 2010). The sequences stratigraphy in Gurpi formation have been recognized base on methods and principles of sequence stratigraphy (e.g., Emery and Myers,1996; Miall, 1997,2000; Van Buchem and et al., 2002).

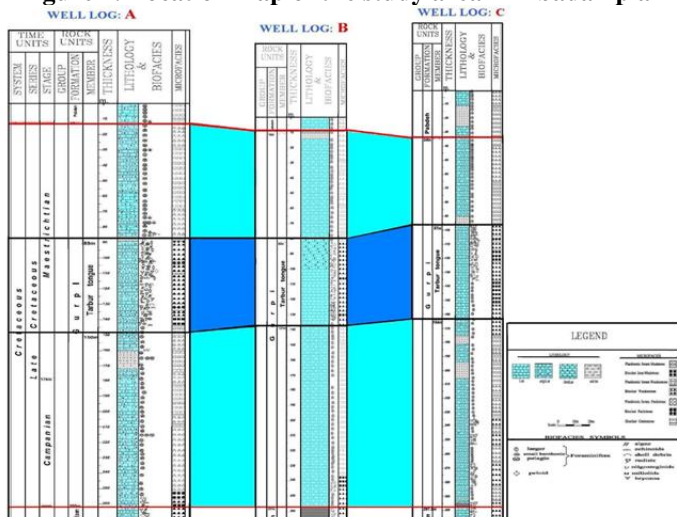
## Microfacies analysis

Assessment of deposits of Gurpi formation in studied three wells lead to know nine facies in outer ramp microfacies belts (A) and middle ramp microfacies belts(B). Outer ramp facies belt (A) in Gurpi formation consist of MF<sub>a1</sub>(planktonic for amini

fermudstone), MF<sub>a2</sub> (planktonic foraminifer mudstone /wackestone), MF<sub>a3</sub>(planktonic foraminifer wackestone, MF<sub>a4</sub> (dolomitized wackestone / packstone), MF<sub>a5</sub>(planktonic foraminifer wackestone), MF<sub>a6</sub>(oligosteginida mudstone), MF<sub>a7</sub> (dolomitized planktonic foraminifer mudstone )and MF<sub>a8</sub> (bioturbated facies). Middle ramp facies belt (B) consist of MF<sub>b1</sub> (bioclast wackestone) and MF<sub>b2</sub> (dolomitized wackestone) (Fig.3:A,B,F,G,I,K and N).



**Figure 1. Location map of the study area in Abadan plain**



**Figure 2. Stratigraphic Column of the Gurpi Formation in the study area**

Main ingredient skeletal allochems of this microfacies are Globotruncanita sp., Hedbergella arca, Hedbergella sp., Rugoglobigerina, Hetrohelix, Oligosteginids and ect. Benthic foraminifer such as: Echinoid, Bryozoa, Miliolid, Bivalve shell and ect. Non skeletal allochems included peloid. Non carbonate components such as Pyrite, Phosphat, Quartz grains and organic matter are frequency found in this facies too (Fig 3: D,H,M) Planktonic foraminifer mudstone is the most abundant in the Gurpi formation in studid area so that a substantial thickness to be allocated and the considerable (Fig3.F). Carbonate mudstone characterized by the lack of fossils due to the high amount of

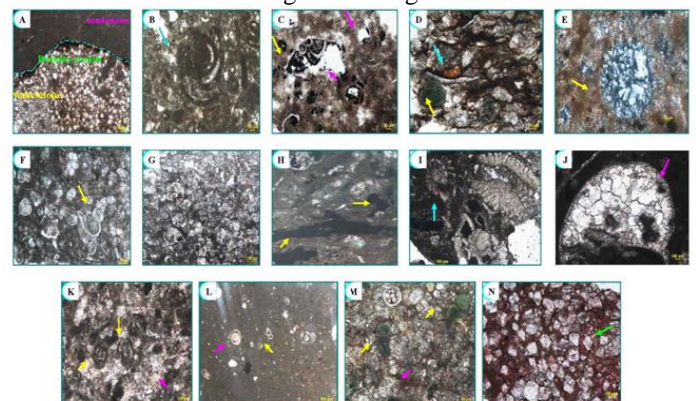
clay materials wich prevents production of organic carbonate (Wilson, 1975). In this microfacies sometimes bioclast fragments are probably from shallower environment which transported by the waves. Therefor some of the benthic and pelagic fossils are seen together(Fig 3.L). Bioclasts mostly coated by micritic envelope.

The main bioclast of planktonic foraminifer wackestone is Hetrohelix in a row but some wells can be seen in two rows(Fig3.F).This facies in studied wells is in upper and lower Gurpi formation. The main process of diagenesis in this facieses included:dissolution,phosphatization,glaucunitization,cementatio n,porosity pyritization and dolomitization. Pyritization and phosphatization have been seen in chambers of planktonic foraminifer and (vuggy, channel and fracture) porosity(Fig 3.H).

Phosphatization carbonate grains after deposition also can be done in reducing conditions (Fig3. D). The most important source of organic phosphate are foraminiferal(Prevot and Lucas, 1986). In some facies incomplete micritization causes that formed micrite envelope (Bathurst,1975) in around of skeletal and Non skeletal carbonate components. Existing just planktonic foraminifer and inexistent of benthic foraminifer in MF<sub>a1</sub> to MF<sub>a7</sub> facies shows deep marine environment and MF<sub>a6</sub> microfacies with oligostegina shows a shallow deep marine environment (Fig 3: F,G).

Due to mud supported in MF<sub>a1</sub> facies, we can say condition of forming is relatively calm condition (Flugel, 2010)(Fig3 A). Generally amount of lime mud in carbonate rocks indicates degree of turbulence and turbulent environment. In addition to increasing the amount of clay in the part of environment for along time to confirm calm environment (Tucker, 1990; Flugel, 2004).

Dolomitization could observe in B and C well (Fig 3: A,N). The process observe in this formation as interparticle, molding and channeling porosity. Interparticle porosity could observe in wackestone facies (Fig3,C) on skeletal spaces such as Globotruncanita and another Placiec.Fracture porosity is Nonfabric selective porosity(Tucker, 2001) that occur because of tectonic stresses and during burial diagenesis in carbonate rocks.



**Figure 3. A) Dolomitized mudstone to wackestone. B)Bioclast wackestone. C) Interparticle porosity in chambers of Globotruncanita sp. D)Glaucunitization and Phosphatization in pelagic foraminifers. E) Quartz grains . F) Planktonic foraminifer wackestone facies with one row Hetrohelix. G)Planktonic foraminifer packstone. H) Pyritization process . I) Bioclast wackestone with Sirtina. J)Dissolution and Cementation process (Drusy cement). K) Bioclast wackestone with benthic foraminifer such as : Miliolid , Echinoids,.. L) Bioturbated wackestone. M) Gloconitization process in chambers of planktonic fossils. N) Dolomitized wackestone**

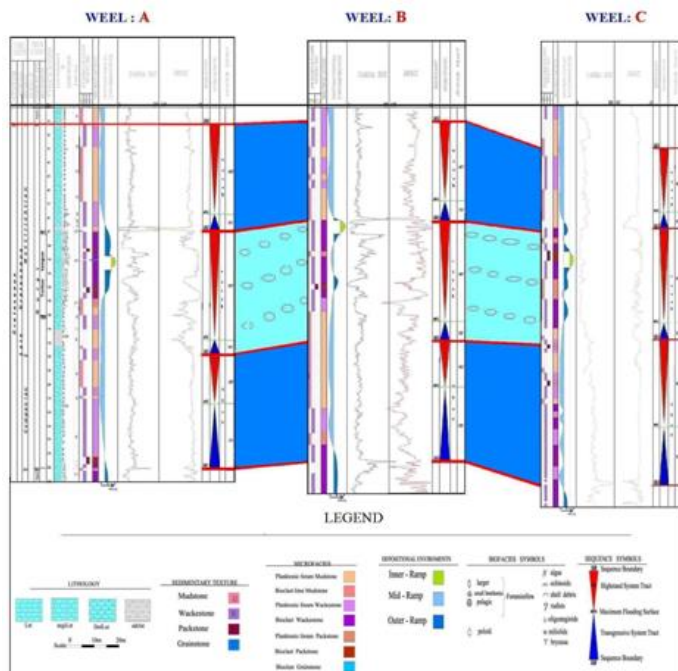


### Sequence stratigraphy

Gurpi formation in subsurface show different thickness and facies together. Generally field and lab studied show that sequence and facies have been deposited in distally stepend ramp. In such platform transgressive system tract (TST) and highstand system tract (HST) sedimentary group developed but low stand tract (LST) are limited. Vertical facies variation of the Gurpi formation indicate the presence of two 3<sup>rd</sup> order depositional sequences in the study area (Wells: A,B,C) (Fig 4). The first sequence consist of the lower Gurpi formation (Companionian) are (well A: 82 meters, well B: 87 meters and well C: 123 meters) thick and includes outer ramp and middle ramp facies belts. The second sequence consist of the upper Gurpi formation (Maestrichtian) are (well A: 77 meters, well B: 80 meters and well C: 63 meters) thick that includes outer ramp facies belts.

#### Sequence 1:

This sequence with different thickness can be observable in studied area. The most thick has been seen in well C. The lower contact of sequence 1 and the upper contact of sequence 2 are type 1 unconformity (SB1) and the contact between of these sequence is type 2 unconformity (SB2). The age of this sequence is companion.



**Figure 4. Correlation between Wells A,B and C in the Abadan Basin**

This sequence detected by sequence boundary type of one (SB1). Transgressive system tracts (TST) of first sequence is 45 meters thick that consist of thick layer of limestone that started with planktonic foraminifer wackestone/ mudstone facies in deep marine environment and at last ended with calciturbidite facies. Maximum flooding surface (MFS) has been known with pelagic facies. Highstand system tract (HST) of this sequence is 37 meters thick that consist of planktonic foraminifer mudstone / wackestone/ packstone facies related to deep marine environment. This sequence ended by sequence boundary type of two (SB2).

#### Well B:

Transgressive system tracts (TST) consist of thick layer limestone with 57 meters thick that started with planktonic foraminifer mudstone/wackestone facies and finished with bioclast lime mudstone/wackestone facies of open marine environment. Maximum flooding surface (MFS) has been

known with pelagic facies. Highstand system tract (HST) of this sequence is 30 meters thick that includes planktonic foraminifer mudstone/wackestone related to deep marine environment (outer ramp belt). The lower contact of this sequence has been recognized by sequence boundary type of one (SB1).

#### Well C:

Transgressive system tracts (TST) consist of medium marl layer with planktonic foraminifer wackestone, dolomitized wackestone, dolomitized bioclast wackestone and planktonic foraminifer mudstone facies. Lower part consist of deep marine facies and pelagic fossils related to outer ramp belt and upper part of this sequence includes open marine facies. The thickness of TST is 47 meters.

Maximum flooding surface (MFS) has been known with light brown coloured to medium layer limestone of bioclast wackestone facies related to open marine environment. The thickness of highstand system tract (HST) is 76 meters that includes bioclast wackestone, planktonic foraminifer mudstone/wackestone and dolomitized planktonic foraminifer wackestone facies. Lower part of HST is from open marine facies and upper part is from deep marine facies.

#### Sequence 2:

The second sequence consists of the upper Gurpi formation (Maestrichtian). The thickness of this sequence in wells A, B and C is different. In well C the second sequence has the least thickness. The upper contact of sequence 2 is type of one unconformity (SB1) but the lower contact is type of two unconformity (SB2).

#### Well A:

Transgressive system tracts (TST) of second sequence is 14 meter thick that consist of medium marl layer with planktonic foraminifer mudstone / wackestone facies related to deep marine in the lower part and bioclast lime mudstone facies related to open marine environment in the upper part. Maximum flooding surface (MFS) has been known with medium layer limestone and planktonic foraminifer wackestone facies from deep marine environment. The thickness of highstand system tract (HST) is 63 meters, that consist of planktonic foraminifer mudstone / wackestone. The lower contact of this sequence is sequence boundary type of two (SB2) and the upper contact is type of one (SB1).

#### Well B:

The lower contact of this sequence has been recognized by sequence boundary type of two (SB2). Transgressive system tract (TST) is 24 meters thick that started and finished with planktonic foraminifer mudstone/ wackestone facies related to basin. Maximum flooding surface (MFS) has been known with pelagic facies. Highstand system tracts (HST) of this sequence is 56 meters thick that includes planktonic foraminifer mudstone/ wackestone facies related to outer ramp belt. This sequence ended by sequence boundary type of one unconformity (SB1).

#### Well C:

The upper contact of this sequence has been recognized by sequence boundary type of one with marl layer. Deposits of transgressive system tract (TST) with 13 meter thick includes planktonic mudstone/ wackestone facies. The lower part of (TST) consist of marl layer and planktonic foraminifer mudstone facies of deep marine environment. Maximum flooding surface (MFS) has been known with planktonic foraminifer mudstone facies and argillic limestone with pelagic fossils (Maestrichtian). Highstand system tract (HST) is 50 meters thick that includes planktonic foraminifer mudstone / wackestone related to outer ramp belt.

### Conclusion

- Gurpi formation (Companian- Maestrichtian) is a cap rock in southwest of Iran. The lower contact of Gurpi formation with Illam formation is gradational but the upper contact with pabdeh is unconformable.

-Investigation of rock deposits of Gurpi formation (Companian- Maestrichtian) shows that most part of this formation consist of argilic limestone, marl and intercalation of dolomite and dolomitic limestone.

- Due to thickness of Gurpi formation in wells A,B and C from north to south in study area, be added on their thickness of Gurpi formation, so that the maximum thickness has allocated in well C.

- Petrography studies of thinsections show that pelagic foraminifers are main skeletal allochems in studied wells.

- Assessment of deposits of Gurpi formation in studied area lead to know eight facies in outer ramp microfacies belt(A) and two facies in middle ramp microfacies belt(B). According to studies facies of Gurpi formation, outer ramp microfacies belt allocated the most thickness to themselves.

- Based on sequence stratigraphy , in the studied area Gurpi formation have two sequence (3<sup>rd</sup> cycles). The first sequence consist of the lower Gurpi formation (Companian) and the second sequence consist of upper Gurpi formation (Maestrichtian). All of the sequence boundary based on Gamma – ray log are correlated with each other. The lower contact of sequence 1 and the upper contact of sequence 2 are type of one unconformity (SB1) and the contact between two sequences is type of two unconformity (SB2). The minimum thickness of the second sequence, can be seen in well C.

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