J. Basic. Appl. Sci. Res., 3(3)999-1004, 2013

ISSN 2090-4304
Journal of Basic and Applied Scientific Research
www.textroad.com

The Microfacies and Sedimentary Environments of Surme Formation In the Kish Gas Field, Persian Gulf, Iran

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ABSTRACT

Surme Formation (Lower Jurassic- Lower Cretaceou) has created one of the most important gas fields in the Persian Gulf in the South of Iran. The present study aims to investigate facies changes of Surme Formation in Kish Gas Field and to interpret its conditions and sedimentary environments. Microscopic studies of the bits obtained by drilling operations in Kish Gas Field have led to the identification of 19 microfacies. Based on their formation conditions, these Microfacieses are classified into: 1. Tidal flat 2. Lagoon 3.Barrier, and 4. Open marine areas, which is indicative of a carbonate ramp with a generally even morphology in tropical areas.
KEYWORDS: Surme Formation, Microfacies, Sedimentary Environment, Persian Gulf, Kish Gas Field.

1. INTRODUCTION

Surme formation (Tuarsin-Titonin) is the oldest of Khami group (Jurassic- lower Cretaceous), and it is seen in some parts of central and eastern regions of Zagros[1] in some parts of the southern parts of Iran. Its thickness reaches 1000 meters and consists of three carbonate and two shaly parts. For the first time, James and Wind[2] introduced and described Surme Formation as the lowest part of Khami group (Jurassic – lower Cretaceous).

Recently, Jalilian[3] and Lasemi and Jalilian[4] studied facieses, sedimentary environments and sequence stratigraphy of the outcrops of this formation in surface outcrops of this Formation. The main purpose of this dissertation is to analyze facieses and identify the sedimentary environment of Surme Formation in Kish gas field, Persian Gulf.

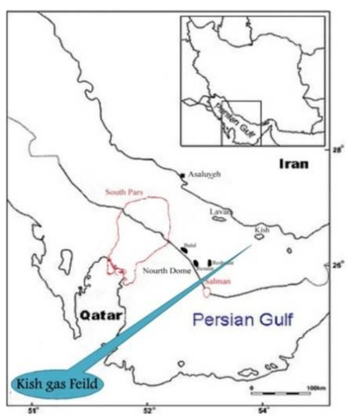

Figure 1. The location of Kish Gas field

Geologic position and Stratigraphy

Zagros zone refers to the regions in the south west of Neotethyscrack including the heights in the West and South West of Iran. Zagros is one of geologicalzones of Iran, and it is part of Alps-Himalaya mountain-generating belt that extends from north west to south east with an approximate length of 1500 kilometers and a width of 1003 kilometers from the south west of Turkey to Hormoz Bay in Iran. In the Kish gas field, the thickness of Surme Formation is more than 672 meters and is mainly made of Dolomite, Dolomitic Limestone and Limestone with some variations of Shale and Marll. Petrological composition of this formation is such that it can be divided into three groups of lower carbonate, lower shale, middle carbonate, upper shale and upper carbonate. In the mentioned regions, Surme Formation with erosional unconformity should be separated from NeirizFormations (Lower Jurassic) in the bottom and Fahlyan formation (Lower Cretaceous) at the top.

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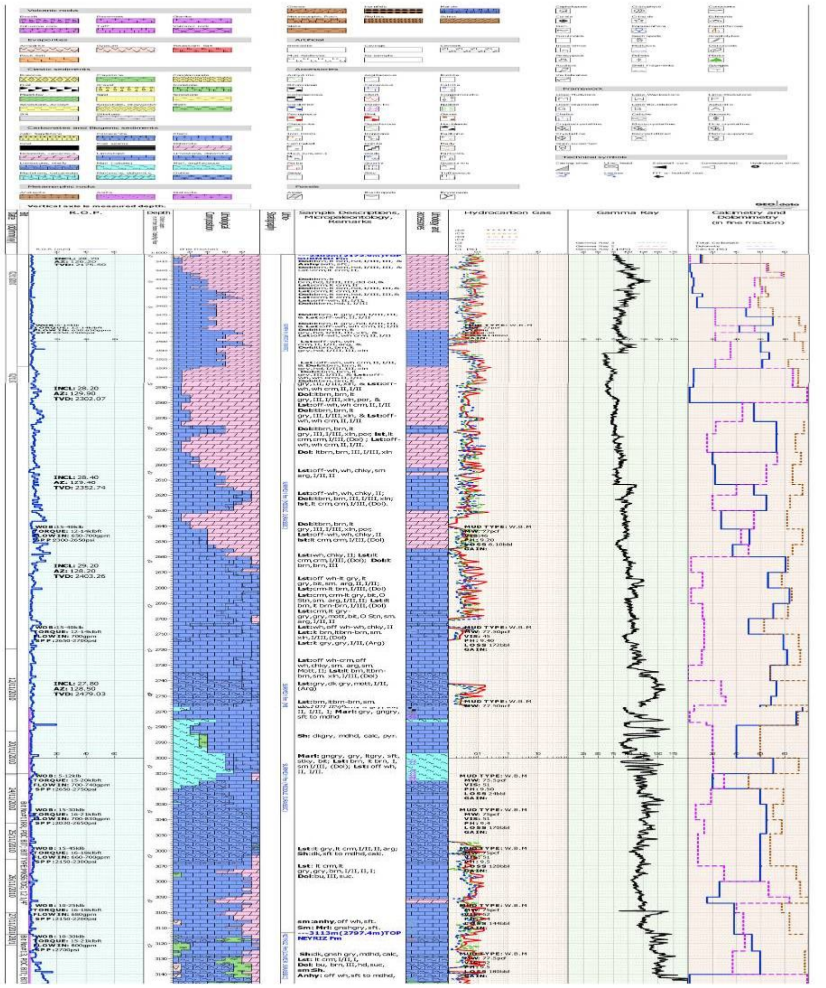

Figure 2; Stratigraphicclumn of Surme Formation in the Kish Gas Field

Microfacies

Following petrographic analysis of the limstones of the Surme formation in the area under study, 19 Microfacies, indicative of shallow carbonate environment, have been identified which, according to Walter's law, are formed beside each other and are classified as four types of facieses belts, intertidal, lagoon, barrier and open marine.

A) The Microfacies of Intertidal Flat

A1) Layer anhydrite to mass anhydrite

Layer to mass Anhydrite with an Anhydrite frequency of 80 percent has parallel and semi-parallel radial crystals of wavy laminates and co-dimensional crystals with a jagged margin. It is formed in interlayer position with noodles and spars anhydrite crystals. Inside the layers and noodles, anhydrite are seen as long micro-particle crystals. This Microfacies is the same as Flugel[5] standard RMF25 microfacies.

A2) BioclasticWackstone

In this facieses, a lot of mud with 15 to 20 percent of allochems is scattered. Skeletal fragments consist of Miliolids with a size of 0.5 to 0.75 millimeters and a frequency of 10 to 12 percent. In this facieses, non-organic allochems do not exist.

In this facieses, the frequency of lime mud shows low energy sedimentation; moreover, the existence of benthic foraminifera like miliolids indicates limited circulation of water and the salty feature of sedimentary environment[6]. The low level of skeletal fragments also indicates the nearness of these facieses to seaside environment. This microfacieses has been equated with RMF20 by Flugel.

A3) Mudstone

The absence of allochems and the existence of micrit as the matrix and main framework, and the existence of ferrumoxide is the main feature of this microfacies. Recrystalization of Dolomite in this microfacies is among diagenetic processes in this microfacies. This microfacies has been equated with RMF16 by Flugel.

Supratidal environment or the upper limit of tide flat includes this microfacies. Lim-mudstone is the label used for this type ofmicrofacies.

A4) OoidIntraclasticGrainstone:

This microfacies includes 10% Ooid, 40%micriticintraclast , 5% to 10% pellet, and 30 to 40%spary calcite cement of block and drusy type. The existence of ooid in main allochems of this microfacieses along with angleless and carried micriticintraclast and a background containing carbonate cement show sedimentation conditions in ahieghenergy environment.

This microfacies matches Wilson's number 6 facies belt and Flugel's number 15 microfacies, Wilson[7] and RMF26 introduced by Flugel.

A5)Bioclastic Grainstone with foraminifera and pellet

Pellet may be mentioned as a non-skeletal component in this microfacies. Other skeletal components may include bentic foraminifera such as trocholina. The particles are of medium roundness, indicating sedimentation in energy-loaded environment. These microfacies are equal to standard microfacies of RMF26 offered by Flugel.

A6) PelleticGrainstone

The only non-organic carbonate component in this microfacies is pellet with a frequency of 30 to 40 percent formed in Sprite background. This microfacies is equated with the standard microfacies of RMF4 offered by Flugel.

(A7) Interaclast PelleticPackstone-Grainstone

Non-skeletal components of this microfacies include 40% intraclast, 30% pellet and in some places dolomitizied. This microfacies includes 20 to 30% micritmatrix and 10 to 20% sprite cement. Moreover, the existence of sparycement indicates the high level of energy under the barrier environment and washing-up of micrit the possibility of the formation of sparite cement between the carbonate allochems. This microfacies matches Wilson's number-6 facieses belt and RMF26 offered by Flugel.

The most frequent allochems in this facies is intraclast. They are rounded to subrounded, and are medium sorted. The frequency ofintraclasts is almost 45 to 50 percent, and their size is between 0.5 and 1.5 millimeters.

Foraminifera are among the skeletal and non-skeletal fragments in this microfacies; some green algae pieces are also observable. Pellets and ooids are among non-skeletalallochems. The space between all particles is filled with cement; these conditions and the presence of ooids and cements indicate their sedimentation in ahieghenergyenvironment.

Analysis and discussion

Grainstone texture, the presence of particles like intraclast, coated particles and relatively good sorting indicate their formation in tidal flat[5].

B) Lagoon facieses group (inner ramp)

B1) PelleticPackstone

The most important components of this microfacies are micropelloidsof 40 to 80 microns with a frequency of 60 percent scattered in mudstone matrix.

In these microfacies, pellets, intraclast are also observed, indicating its transfer from the lateral neighboring environments. The high frequency of pellets and mud-supported texture in these microfacies confirm sedimentation in low energy environments like lagoon. This microfacies are equal to standard microfacies of RMF4 offered by Fluge[5].

B2) Pellet BioclasticPackstone

This microfacies includes 5 to 10 % sponge spicules, 3 to 5 % intraclast, which is among non-skeletal components of this microfacies, as well as 40 to 50% pellet. In some places, there exist self-formed dolomite crystals, which include 10 % cement and 30 % Micrite.

The presence of skeletal fragments carried by lagoon environment to a great extent (40 to 50 percent) is indicative of transfer from lagoon and relatively shallow water conditions affected by sea waves. The presence of some micrite in the background of barrier environment due to low-energy environment or the crushing or fragmentation of pellets results from different diageneticfactors including condensation[8]. Relatively good sorting of fragments and sedimentary grains is because of high energy in the environment. These microfacies match Wilson's Number-7 facies belt and Flugel's 18-standard microfacies as well as Wilson and RMF26 offered by Flugel.

B3) PlanctonicPackestone

The most frequent main ingredient of this microfacies is pellet with a frequency of 25 percent along with small fragments of Planctonicframinifera of globigerina type. Other fragments are sponge spicules and intraclasts. These microfacies are equal to Flugel's standard RMF4 microfacies.

B4) Mudstone with BenticForaminifera

The components of these microfacies are small benetic foraminifera of Dekhania, Trocholina and small bioclasts scattered inside the lime-mud matrix. The scattered feature of bentic foraminifera and its origination is controlled by the mutual effects of the organic materials and oxygen.

The frequency of lime-mud indicates low hydrodynamic conditions and low-energy environment. These microfacies are equated with the standard RMF16 offered by Flugel[5].

This microfacies includes 5 to 10% sponge spicules, 3 to 5% intraclast, and 40 to 50% pellet, and in some parts there are Dolomite self-formed crystals.

Interpretation and discussion

Lagoon is a wide area with limited and variable water circulation. A characteristic of this position is having the conditions of a surrounded sea like low level of the production of Oxygen and higher salt level of the environment. Generally, greater frequency of Pellets and Bentic foraminifera and mud support of this facies confirm sedimentation in still lagoon environments.

C) Bar or barrier microfacies

C1) Intraclastic Grainstone

This microfacies includes 40 to 50 percent semi-rounded to well-rounded and subrounded intraclasts. Roundedness and sorted feature of the particles indicate higher environmental energy. The higher energy of the environment washes up carbonate lime-mud in the particles. This microfacies is equated with the standard RMF24 microfacies offered by Flugel.

C2) Oolitic Grainstone

Ooids is the only allochem composing this microfacies, and sparitic cement has filled the background and space between the particles. Sorting varies from medium to goodsorted. This microfacies is equated with the standard RMF24 microfacies offered by Flugel.

C3) BioclasticIntraclastic Grainstone

The most important components of this microfacies are intraclasts and different bioclasts with a frequency of 25 to 30 percent. The size of intraclasts varies from 400 to 1000 microns. The sorting of the particles of this microfacies is medium. Grain-supported fabric and well-roundhng of intraclasts indicate that this microfacies have been obtained in a high energy environment as a result of washing up the carbonated elements. The most important skeletal fragments of this microfacies are bentic foraminifera like textularia. This microfacies is equated with the standard RMF24 microfacies offered by Flugel.

Analysis and discussion:

Grainstone texture, the presence of particles like intraclasts, the absence of the development of micriteorthochems, coated grain and relatively good sorting indicate their formation in a high energy environment like a barrier.

D) Open marine microfacies

D1) BioclastPellet Wackstone

This microfacies include 10 to 15% fossil fragments of the sponge spicules and 40 to 50 percent pellet in a matrix consisting of 20 to 30 percent micrite; the presence of these crushed fossil fragments indicates transfer by waves from the main place of their living (i.e. from lagoons and shallow environments to semi-deep and open seas) and their sedimentation with decreasing energy of the wave[5].

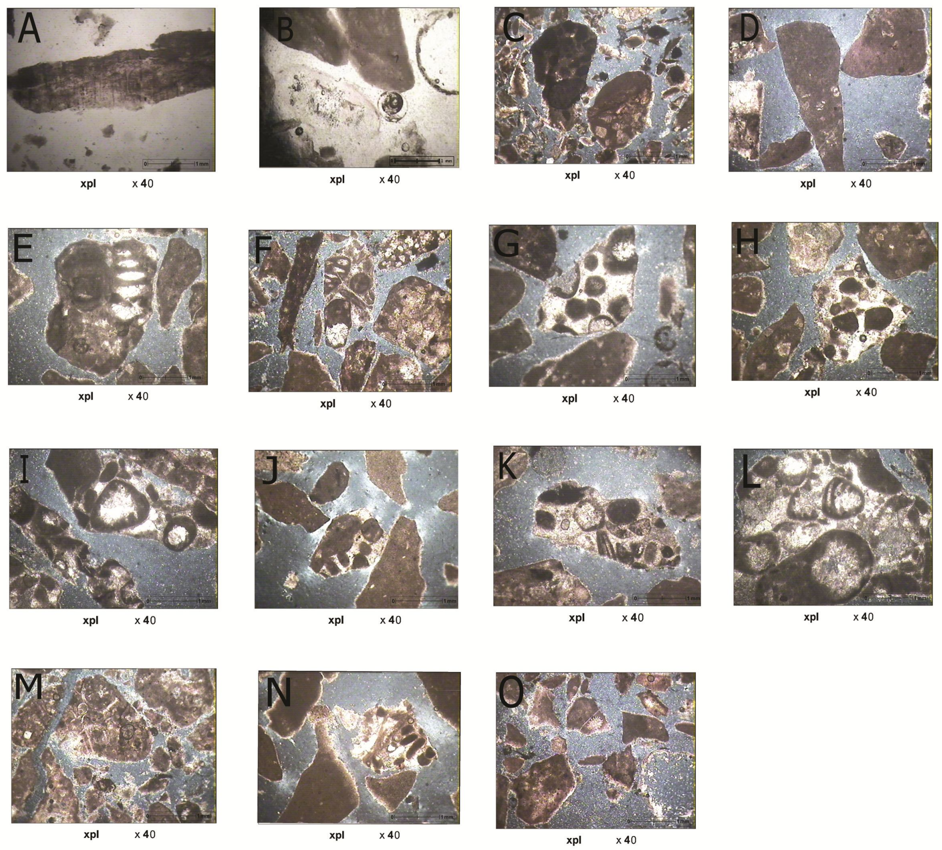

Figure 3; Microfacies of Surme Formation;

Tidal flat microfacies:mudstone(A), anhydrite(B), Lagoon microfacies: pelleticpackstone(C), mudstone with some benticframinifera (D), bioclasticwackstone(E), Bar/Barrier microfacies: pelleticgrainstone(F), ooliticgrainstone(G), intraclasticpackestone-grainstone(H), oolit, intraclasticgrainstone(I), pelleticgrainstone(J), intraclasticgrain stone(K), bioclastic, intraclasticgrainstone(L), Open Marine microfacies: pelletic, bioclasticpack stone(M), bioclasticlim mudstone(N), spong spicule wackstone(O),xpl, X40.

Moreover, in these microfacies, pellets are almost rounded, indicating the transfer of these fragments from their main environment by the waves and sedimentation in open, semi-deep and deep marine. This microfacies matches Wilson's number-4-facieses belt, Flugel's number 5 standard microfacies and Wilson's RMF3 offered by Flugel.

D2) Sponge Spicule Wackstone

This microfacies includes 10 to 15 % sponge spicules along with non-skeletal components of pellet in a micrit background of 50 to 60 percent. The presence of skeletal allochems like sponge spicules along with a little amount of pellet are among the determining factors of deposit of this microfacies under the open marine conditions.

Sponges and the fragments of their spicules are among the main features of deep sea environment, deep lagoon conditions and cold water condition[8]. In this microfacies, little number of skeletal fragments (Wackstone) also indicates the unfavorable conditions for the growth of the creatures.

These microfacies match Wilson's number-1-facieses belt and Flugel's and Wilson's number 3 standard microfacies and RMF1 offered by Fluge[5].

D3) BioclasticLime Mudstone

This facies ranges from gray mudstone to fossiliferous mudstone, and in some places, it has less- than 10 percent non-skeletal components of mainly pellet or superficialooid. This microfacies contains more than 40 percent pelletsin about 20 to 40 microns size. This microfacies equate RMF4 facieses offered by Flugel and SMF2 facieses offered by Flugel and Wilson.

Conclusion

Nineteen microfacies have been identified for Surme formation which are attributed to three sub-environments of intertidal stratum, inner ramp (lagoon), middle ramp (barrier) and outer ramp (open marine).

Intertidal sub-environments: anhydrite, bioclasticwack stone, mudstone, intraclasticgrain stone with ooids, intraclasticgrainstone-packstone with pellets, bioclasticgrainstone with foraminifera and pellets, pelleticgrainstone and intraclasticgrainstone.

Inner-ramp sub-environment (lagoon): mudstone with bentic foraminifera, pack stone containing planktons, pellet bioclasticpack stone, pellet bioclasticwackstone and pellet packstone.

Middle ramp sub-environment (barrier): intraclastic grain stone, oolitic grain stone, intraclastic bioclasticgrain stone.

Surme Formation in the region under study, has the potential for sedimentation in intertidal, inner ramp (lagoon), middle ramp (barrier) and outer ramp (open marine), but it has maximum thickness in lagoon, and the existence of pellets and intraclasts, the absence of carbonate structures, absence of slump and sliding structures, prevalence of relatively low energy in intradidal and lagoon strata all confirm the formation of this carbonate sequence on one carbonate platform of ramp type.

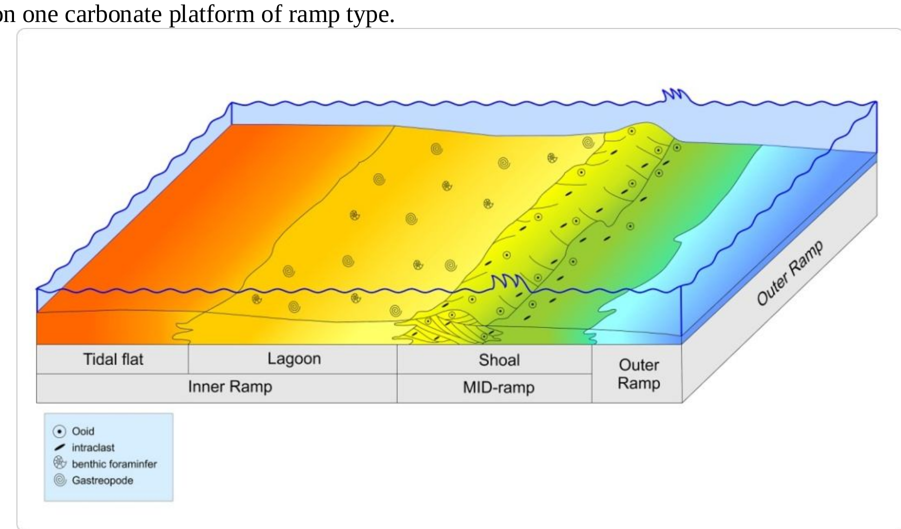

Figure 3: Sedimentary model of Surme Formation in Kish gas field in Persian Gulf.

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