

## Facies and Sedimentary Environment of the Late Cretaceous units at Abegarm(Avaj) Area

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### ABSTRACT

An investigation was made on the facies and sedimentary environment of upper cretaceous rocks at north west of Abegarm(Avaj) area. This study has also covered carving lime sediments mainly being micritic and sparitic with fossil(bioclust) markings, such as: Echinoderm, alga, lamellibranch, brachiopod and bryozoa. Field and microscopic studies led to recognition and separation of 10 carbonate and carving facies as follow: Group of open marine facies that include 1- Bioclastic mudstone, 2- Bioclastic wackstone, 3- Bioclastic packstone, Group of barrier facies that include 4- Bioclastic grainstone, 5- Grainstone packstone, Group of lagoon facies that include 6- Bioclastic packstone, 7- Peloid wackstone Group of continental facies that include, 8- Litharenite, 9- Sublitharenite and 10- Gerywacki. By interpretation and analysis of these microfacies and their related environment we shall be able to recognize the old geographical(palaeobiogeographic) condition in this region which has proven to have been a ramp type carbonate platform with a nearly uniform slope(homodinal ramp).

**Key words:** Sedimentology, Abegarm(Avaj), Lithology, Facies, Sedimentary environment.

### INTRODUCTION

During the albian, pre-albian and cenomanian epochs, the existed shallow marine at the central part of iran has considerably expanded its territory(Seyyed Imami, 1971 and 1997). The stratum at different zones of central part of iran prove the occurrence of biogenesis of animals during this era (Mohammadi *et al.*, 2014) , and indicate that this region is situated at central part of iran and at north - west of Abegarm Avaj. The outcrops observed at the region under study are approximately 400m high and are attributed with following geographical coordinates:

Geographical Length: N35/4782811  
Geographical Width: E49/602418

The strata protract north - southward with 60degrees gradients and due to tectonic activities they are weak and occasionally get steeper or milder. Connecting paths to this region are:

Path: 21Km north - west Abegarm Avaj road from Shakhdar. The weather of the region is submountainously mild. Samples were collected at about constant transversal distances vertical to the strata. The specimens which were made into thin cut pieces underwent precise lithological studies thereby their different elements were distinguished and separated. By synthesizing the Folk(1973) and Dunham(1962) approaches, the facies were given titles. This paper is a part of a research on lithological attributes, sedimentary facies and environmental aspects of the formation of cretaceous sediments and rocks at

the region under investigation (Mohammadi *et al.*, 2014).

### Stratigraphy

At the concerned region the limestone sedimentations mainly included micritic and sparit limes containing some traits of fossils(bioclasm markings) such as berizoa, spicule sponge, echinoderm and brachiopodo in formations of 250m thickness. The strata protract in north - south direction at 60degrees ramp being weak and occasionally steeper or milder due to tectonic activities.

### Procedure

Field studies: After investigating and collecting data, site visits were made in the region and the most appropriate stratigraphy zone for measurement and sampling were chosen. Samples and specimens were gathered using hammers, measuring tape and compass at every 1meter distance and/or at lesser or larger distances where facies and textural variations were seen. Laboratory studies: Selected samples taken from the ground surface were put to analysis, interpretation and rendering of sedimentary environment and for identifying the sedimentary facies and developing a laboratory model of the carbonate and clast facies. Subsequently a stratigraphy pillar was plotted.

### Microscopic facies description

According to microscopic studies on thin cut sections, 7 carbonate facies and 3 carving facies were identified. By review and comparison of these types of facies with facies presented by Flugel(1982) and Wilson(1975) it was clarified that a carbonate ramp environment with a nearly uniform slope are formed. This environment is categorized into 4 groups, namely: open marine, barrier environment, lagoon environment and continental environment each of these having their own sets of characteristics. By taking into consideration the allochems, orthochems, it can be asserted that each group's sedimentary characteristics include facies that we shall be dealing with the most significant ones(Mohammadi *et al.*, 2014).The facies related to average to comparatively great depths of the open marine include the mudstone, wackstone and packstone facies.

### Bioclastic mudstone

This facie contains little allochems(less than 1%) that include crenoid, spicule sponge, bivalves, scallops of molluscs and plagic microfossils in various sizes and within micritic background. In some microscopic samples some cracks clogged with sparit cretaceous is observed. Plagic microfossils and micritic in the facie indicate the existence of sedimentation in a calm and open marine.

### Bioclastic wackstone

This facie is formed from bioclastic(skeletal) fine grains in micritic background. Such bioclastic fine grains include crinoid thorns and small amount of spicule sponge. In some sectors related to this facie, spicule sponges are dispersed in longitudinal and transversal frames with 0.5 to 1mm sizes inside a micritic matrix substance.

### Bioclastic packstone

The elements in this facie include allochems such as alga, bioclastic fine grains(such as: briozova and molluscs in a micritic and sparit background). In this facie allochems are deposited in a calm area.

Figure 6&7. Bioclastic packstone containing alga, bioclastic(skeletal) fine grains and berizoa within a background consisting of micritic and sparit. Left image is under 40x polarized lighting and the right image is under normal lighting

### Interpretation of open marine facies group

Through a vast field and laboratory survey it is found that the above facies are remains in the open marine and shall be dealt with below since these facies are related to the open marine:

1. Facies containing plagic microfossils are deposits in a calm environment at deep sections of the ramp(Pedley 1998).
2. Bioclastic allochem contents such as spicule sponge, radiolaria and echinoderm in a facies indicate that such a facie was formed in open marine(Simo 1993).
3. Mudstone texture with the absence of cement and other facies of high micritic content and low cement allude to environments with low to moderate(open marine) energy levels.

**Interpretation of open marine facies group**

Bioclastic grainstone: Ooids contain concentric laminates deposited around a central core. Older ooids also show the concentric laminates and isodose. Also, the radial and concentric structure in them is well formed. Their core is formed of quartz and carbonate micritic granules. Image below shows various ooid and it can be seen that some contain small cores and thick envelope and others have large cores. This rock also has a large amount of granules(microfossils and fine grained microfossil, intraclasts, ooid and sundry elements) and sparit cement. In the background of this facie, carbonate mud(micrite) is not present. Thus, this facie can have a biogenetical or carving origin and in some cases chemically produced. Fossil pieces contain mollusks and berizoa. intraclasts and ooids content allude to a high energy level environment. Absence of micrite in the spaces between granules yet being filled with sparit cement alludes to an environment with high energy level (Mohammadi *et al.*, 2014)

**Grainstone packstone**

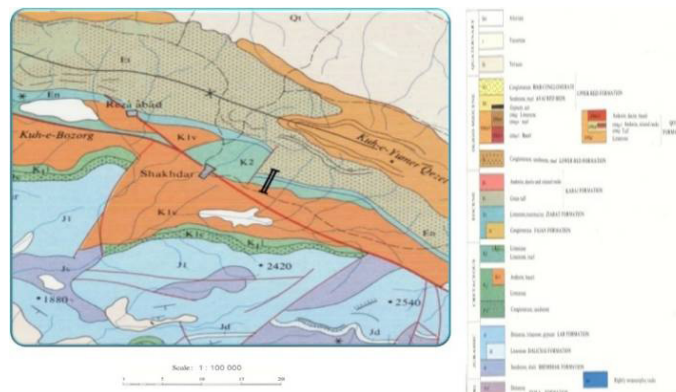
This rock contains high amount of granules and micritic cement with concentration of granules in little amount of depositions and the allochems are a mixture of ooids, intraclasts, fine lime particles, quartz and calcite granules. In this rock, neomorphism of the micrites has taken place.

**Interpretation of barrier - lagoon facies group**

Avast field and laboratory survey shows the formation of facies in a barrier environment and below the reasons for their association of these facies with the barrier is given: 1- Absence of micrites and high sparit content with sparit cement filling within the granule spaces indicate high energy level and a barrier environment(Tucker, 1991). 2- Laminate and superficial ooid and some bentic microfossils allude to a barrier environment(Tucker 1991).

**Bioclastic pakstone**

This facie contains high amount of allochem in a micritic background. Bits and pieces



**Fig. 1: Geological map of the region under study; Avag geological map with 1:100000 scale; geological survey organization of iran**



**Fig. 2: Showing how strata are piled at the region under study**

of fine grained fossils and spicule sponges seen in longitudinal and cross - sections are contained in this facies.

**Ploid wackstone**

This facie mainly contains micrites and pellets and excremental ploidis including first - order allochems. The fine grained fossil and bivalve pieces are sub-allochems that are observable in this facie. Pellets and ploidis seen, are 0.1 to 0.3mm. Due to the presence of microfossils related to a lagoon

environment, the facie has a lagoon environment.

**Interpretation of lagoon environment facies group**

Fossil that had lived during the last stage of deposition of these sediments. Thus, they are to be considered as sedimentary rubbles and not fine grained fossil. Vast field and laboratory surveys show that the defined facies remain at lagoon regions.

1- Ploid and interaclast related to lagoon environment imply the existence of such an environment.

2- Claciticity and micriting of the chamber walls of some of the microfossils and micriting inside the chambers could signify the existence of lagoon environment.

**Description of carving facies**

Litharenites are in fact sandstones with less than 75%quartz and having rubbles less than that in the feldespat. The image below shows sandstones containing quarts, chert and pieces inoculated with iron - oxide with lime concrete content. At the center

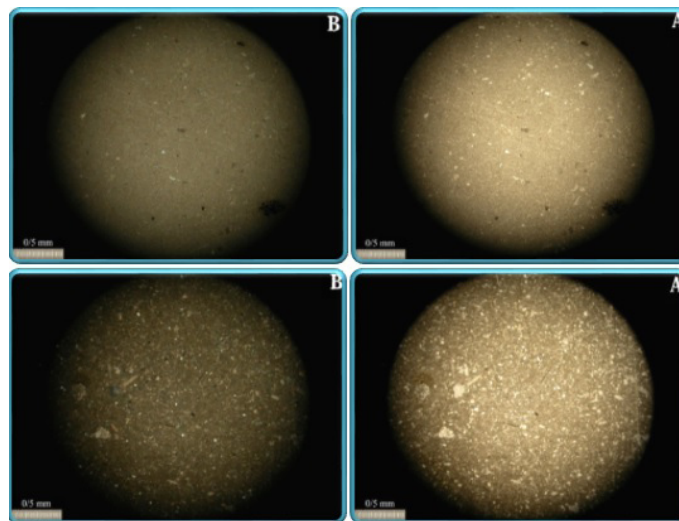


Fig. 3: Biocalstic mudstone containing glagic microfossils under 40x polarized lighting

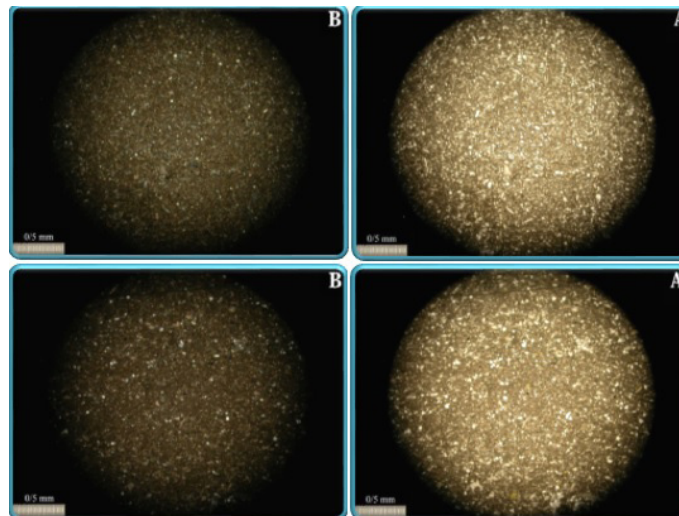


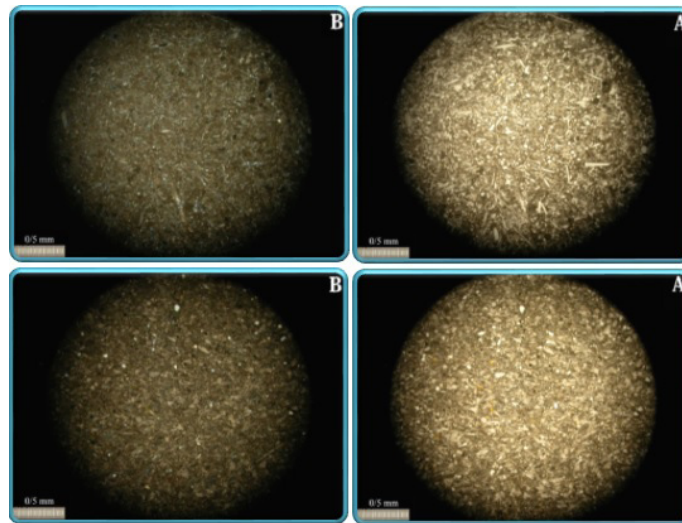
Fig. 4 & 5: Biocalstic wackstone containing crinoid thorns and small amount of spicule sponge inside a micritic substance. The image on the right is under normal lighting and the one on the left is under 40x polarized lighting



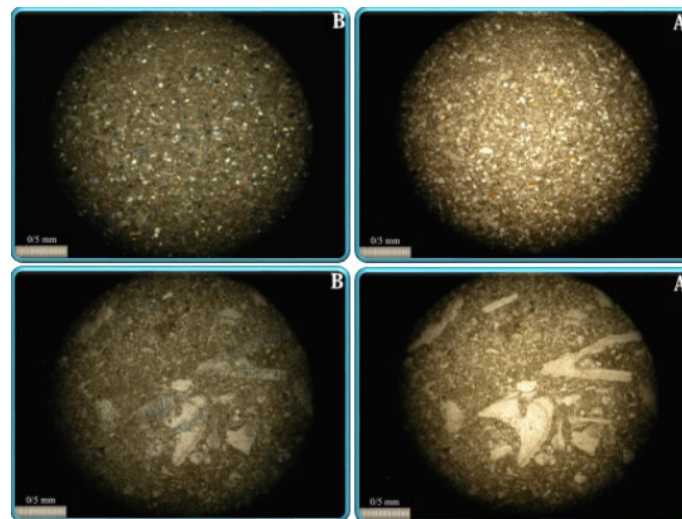
of the image quartz granules and mica sheets are seen. In figures 15 and 16, an arnite barrier can be seen which contains carbonate rubbles. These sediments are also single quartz crystals and plates of echinoderms. Echinoderms are granules with patchy spots and similar interacting colors. In this sample, the echinoderms are a disjoint piece of an old limestone rock and thus are not categorized as fine grained.

**Sub-litharenites**

This is a kind of grit(sandstone) with 75 to 95 percent of its first - order granules made of quartz and has higher rubble content than feldespat. In images 17 and 18, the quartz granules, chert and a little rubble with micritic matrix substance is shown.



**Fig. 6 & 7: Bioclastic packstone containing alga, bioclastic(skeletal) fine grains and berizoa within a background consisting of micritic and sparit. Left image is under 40x polarized lighting and the right image is under normal lighting**



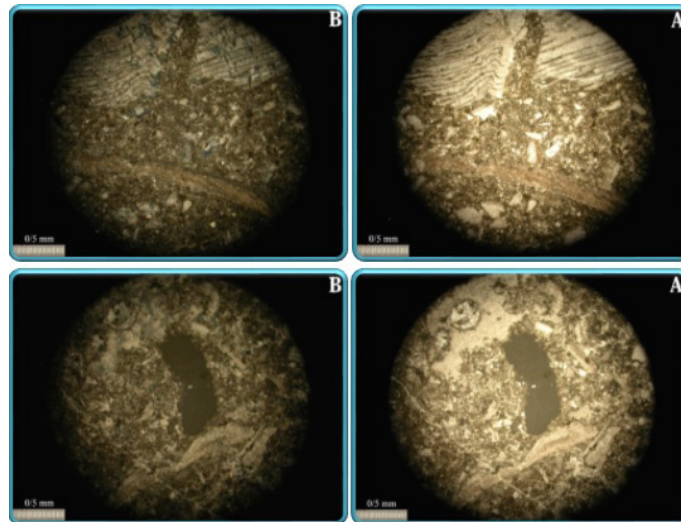
**Fig. 8 & 9: Bioclastic grainstone containing ooids, brachiopodo and quartz granules. Left image is under 40x polarized lighting and the right image is under normal lighting**

**Gerywacki**

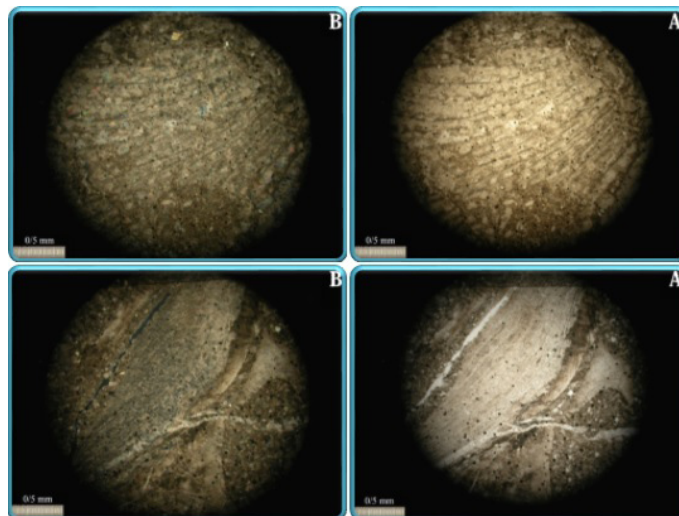
Sandstones with over 15% fine granule matrix. The image below shows a gerywacki with weak sortation and containing high fine granule matrix. Some pieces in these sections are mainly made of single and multiple quartz granules with a small percentage of rubbles.

**Sedimentary environment of cretaceous units at north - west mount shotori at dihuk - tabas region**

According to analysis of acquired results from field surveys and the thin microscopic sections which were also compared with results from standard microfacies distribution models in



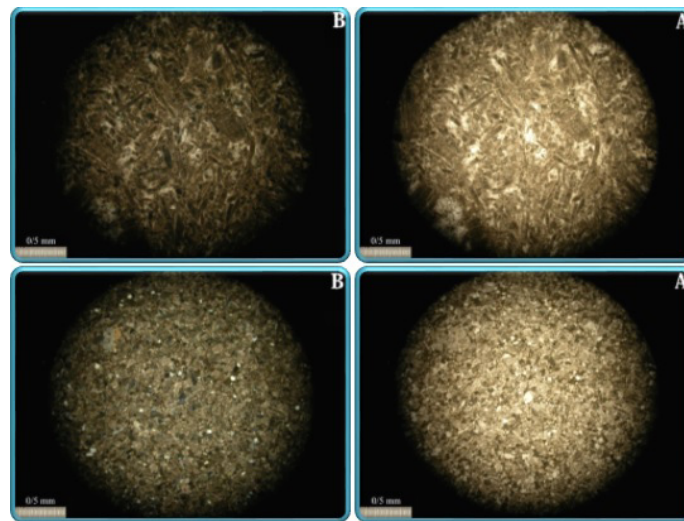
**Fig. 10: Grainstone packstone containing a berizoa microfossil, mollusks and ooid in a sparit background with 40x polarized lighting**



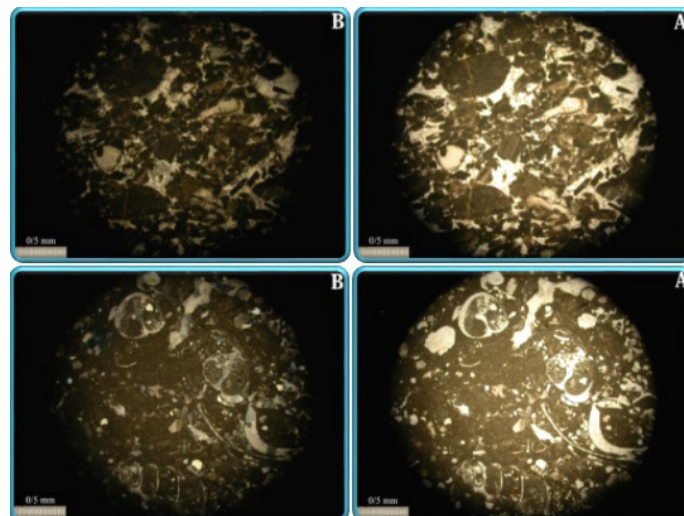
**Fig. 11: Grainstone packstone containing bits of intraclasts, ooid, fine lime particles, quartz and calcite granules. Left image is under 40x polarized lighting and the right image is under normal lighting**

different environments carried out by Wilson(1975), Flugel(1982) and Carozzi(1989), the sedimentary model of cretaceous regions of central iran zone is produced. In presenting this sedimentation pattern, the walter law which in principle holds that strata should lay on each other, is observed throughout. Considering that, the sequence here is to the upper decreasing depth, and with reference to walter law, the facies that sequentially pile on top of each other were laid beside each other during formation,

conditioned that, there had not been any depositional discontinuity. According to the facies genesis as already described, the region under investigation was in open marine, barrier, lagoon and continental environment which indicates that the carbonate platform is a type of ramp with a more or less uniform slope(homoclinal ramp) (Aghanabati *et al.*, 2004). Sketch of sedimentation model of outcropped cretaceous units at north - west of Abegarm Avag



**Fig. 12: Bioclastic packstone containing fine grained fossil pieces and elements, bivalve and laga. The image is under 10x polarized lighting**



**Fig. 13: Ploid wackstone including ploid, grapestone, interaclar, fine grained fossil and bivalve pieces under 10x polarized lighting**

### CONCLUSION

The most important results achieved from the study on deposits of the late cretaceous units at north – west Abegarm Avag are as follow:

- 1 Deposits of cretaceous(limestone) at this zone are about 400meters thick. By identifying and grouping 10 facies into 4 facie groups, it is concluded that these deposits belong to environments such as open marine, barrier

environment, lagoon environment and continental environment.

- 2 The group of related facies has emerged in a carbonate platform of ramp type with nearly a uniform slope(homoclinal ramp).
- 3 The open marine region includes facies 1, 2 and 3; the barrier region includes facies 4 and 5, lagoon region includes facies 6 and 7 and continental environment including litharenite, sub-litharenite and gerywacki.
- 4 The concluding result of the research

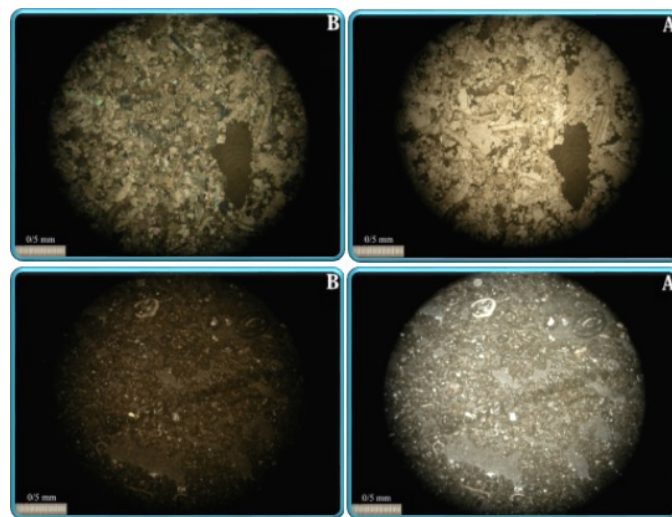


Fig. 14: Litharenite with mica sheets at the centre and quartz granules and pieces inoculated with iron - oxide. The image is under 10x polarized lighting

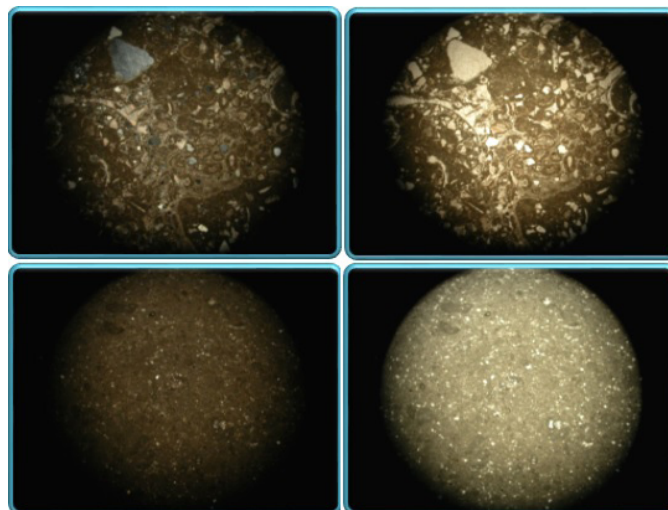
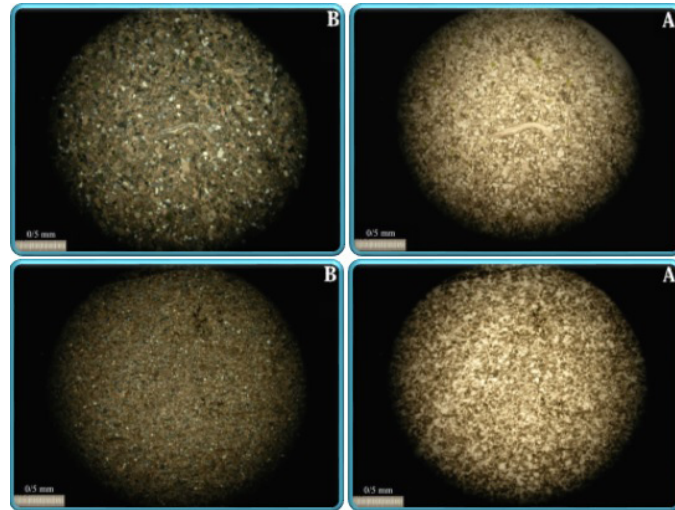
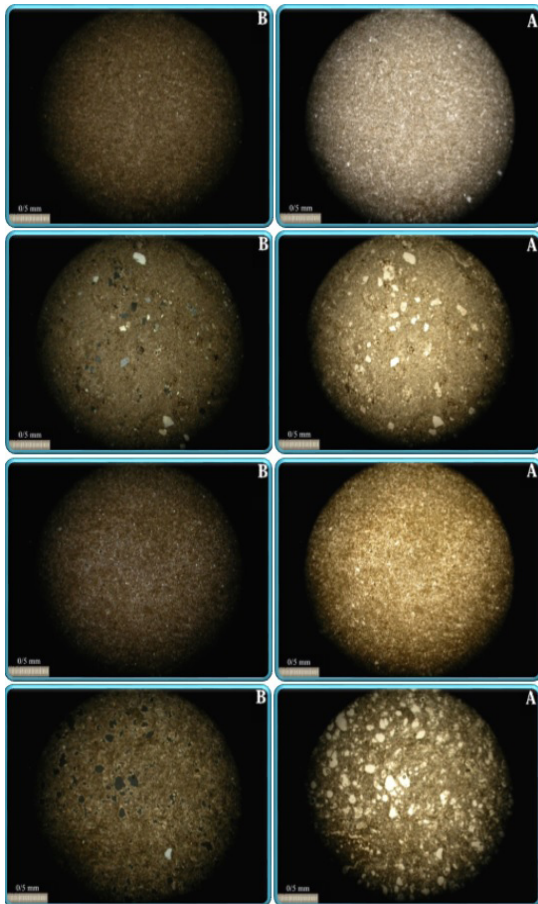


Fig. 15 & 16: Litharenite containing quartz granules and echinoderms plates. The image is under 10x polarized lighting



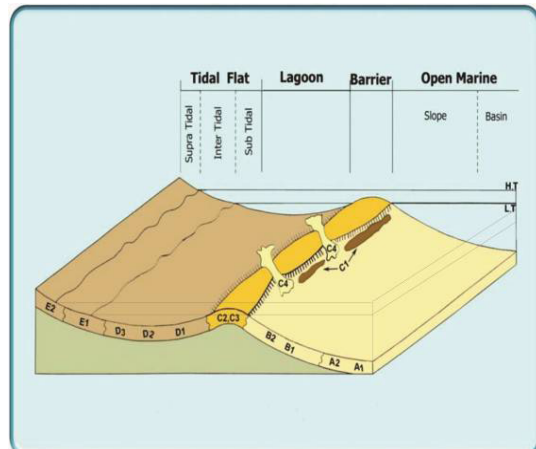


**Fig. 17 & 18: Sub-litharenites with quartz granules, chert and a little rubble with micrite. The image is under 10 x polarized lighting**



**Fig. 19: Gerywacki containing quartz granules and rubbles, under 10x polarized lighting**

and studies can bespeak of the palaeobiogeographic status of the region during sedimentation of cretaceous units at the region under study. After full reviews on stratigraphy pillar and carbonate microfacies and their related environment whilst also making incidental comparison of the results



- 1- Bioclastic Mudstone
- 2- Bioclastic Wackstone
- 3- Bioclastic Packstone
- 4- Bioclastic Grainstone
- 5- Grainstone Pakstone
- 6- Bioclastic Packstone
- 7- Ploid Wackstone
- 8- Litharenite
- 9- Sub-litharenite
- 10- Gerywacki

**Fig. 20: Sketch of sedimentation model of outcropped cretaceous units at north - west of Abegarm Avag**

with each other and full review of the constituting elements of rock facies and with due consideration of the formation of limestone containing bentic microfossils that are related to lagoon environment with micritic and sparit texture and the subsequent emergence of open marine facies, it is made evident that the marine has made headway (progression) at the start of cretaceous epoch. Therefore, the advancement of the cretaceous marine can be clarified due to the expansion of bioclastic facies of the open marine along with microfossils such as spicule

sponge, bivalve, berizoa together with large amount of micrite in the region under investigation (during cretaceous era). In the region under investigation, there has occurred conversion of a shallow sedimentary sea into a deep sedimentary sea having a micritic texture containing spicule sponge and bivalves. The formation of limestone with micritic texture and presence of intraclast show instability in the sedimentary condition and environment and fluctuations in the bed of the sedimentary sea.

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