Early Cretaceous Shallow-Water Platform Carbonates of the Bolkar Mountains, Central Taurides - South Turkey: Facies Analysis and Depositional Environments

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Abstract. The study area comprises southern non-metamorphic part of the Bolkar Mountains which are situated in southern Turkey, eastern part of the Central Taurides. The studied five outcrops form geologically parts of the tectonostratigraphic units called as allochthonous Aladağ Unit and autochthonous Geyikdağı Unit. The aim of this study is to describe microfacies and depositional environments of the Bolkar Mountains Early Cretaceous shallow-water platform carbonates. The Lower Cretaceous is represented by continuous thick- bedded to massive dolomite sequence ranging from 100 to 150 meters thick, which only contains locally laminated limestone intercalations in the Yüğlük section and thick to very thick-bedded uniform limestones ranging from approximately 50 to 120 meters, consist of mainly laminated-fenestral mudstone, peloidal-intraclastic grainstone-packstone, bioclastic packstone-wackestone, benthic foraminiferal-intraclastic grainstone-packstone, ostracod-fenestral wackestone-mudstone, dasycladacean algal packstone-wackestone and ooidal grainstone microfacies. Based on a combination sedimantological data, facies/microfacies and micropaleontological (predominantly dasycladacean algae and diverse benthic foraminifera) analysis, it is concluded that Early Cretaceous platform carbonates of the Bolkar Mountains reflect a tidally affected tidal-flat and restricted lagoon settings. During the Berriasian-Valanginian unfavourable facies for benthic foraminifera and dolomitization were predominate. In the Hauterivian-early Aptian, the effect of dolomitization largely disappeared and inner platform conditions still prevailed showing alternations of peritidal and lagoon facies, going from peritidal plains (representing various sub-environments including supratidal, intertidal area, tidal-intertidal ponds and ooid bars) dominated by ostracod and miliolids, to dasycladacean algae-rich restricted lagoons-subtidal. These environments show a transition in the vertical and lateral directions in all studied stratigraphic sections.

1. Introduction

The Bolkar Mountains are bounded by Ecemiş fault to the east and by the Mediterranean Sea in the south. Units around the Bolkar Mountains are intensively deformed and metamorphosed therefore, non-metamorphic five measured stratigraphic section locations in the south of Bolkar Mountains were determined. These are Yüğlük Mountain, Sandal Mountain, Tırtar North, Tırtar South and Cehennem dere sections (Fig. 1). The present study is based on these five measured integrated stratigraphic sections throughout the Bolkar Mountains. The integrated section of each region obtained by combining and correlating many measured stratigraphic sections. Correlation is made by direct observation and monitoring in the field. The Lower Cretaceous in the Bolkar Mountains composes of

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generally continuous gray-dark gray thick-massive dolomite sequence and gray-light gray thick bedded uniform limestones. The Lower Cretaceous platform succession is disconformably overlain by Upper Cretaceous (Cenomanian) platform carbonate succession (studied by Taslı et al. [1]).

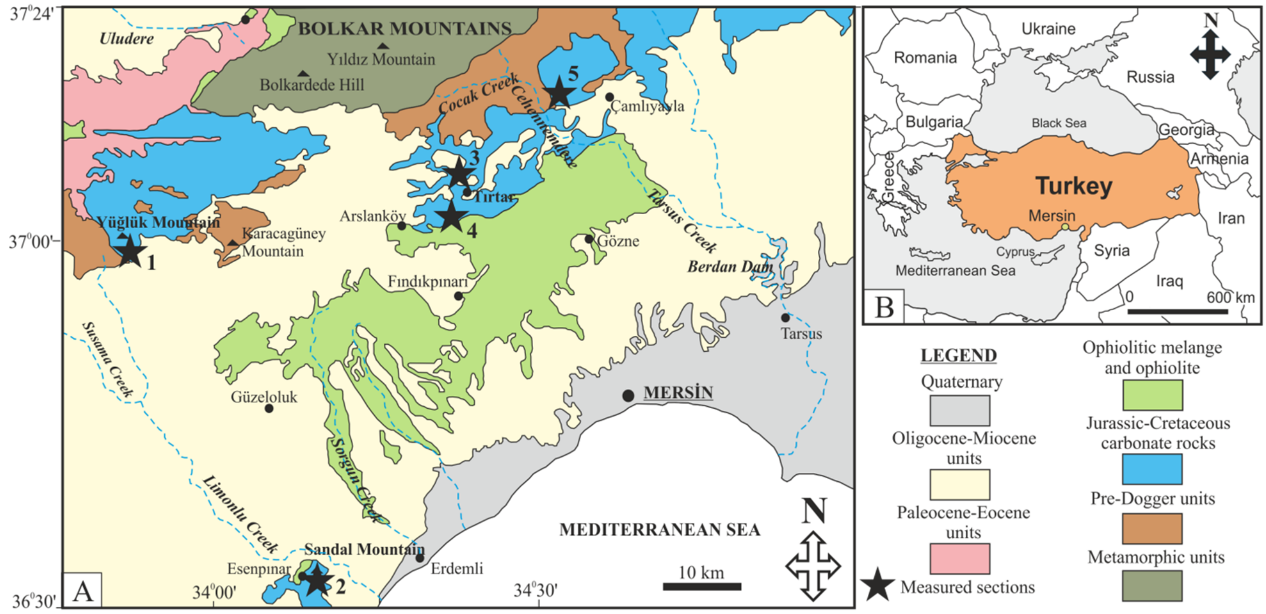

Figure 1. A) Simplified geological map of the Bolkar Mountains (modified after Demirtaşlı et al., [2]) showing the location of the measured stratigraphic sections and B) location map of Turkey

2. Study analysis

The study of the integrated stratigraphy sequences is mainly based on detailed field observations and systematic sampling. Samples were collected and examined in thin section for facies/microfacies and depositional environment analysis under an optical microscope, followed by a semi-quantitative analysis for the percentage estimation. It has been used Plumpley's [3] energy classification for the interpretation. The limestone classifications of Dunham [4] and Embry and Klovan's [5] were used for descriptions. The definitions of standard microfacies types (SMF) and facies zones (SFZ) were performed according to Flügel [6].

3. Microfacies of rocks at area of interest

In total, 415 thin sections have been studied and seven microfacies types have been defined which are briefly described and interpreted (Table 1). These microfacies show a transition and repeat in the vertical and lateral directions in all integrated sections.

3.1 Tidal-flat settings

Tidal-flat platform carbonates representing various sub-environments including supratidal, intertidal area, intertidal ponds and bars, characterized by mainly laminated-fenestral mudstone (MF-1, Fig. 2A) and ostracod-fenestral packstone - wackestone (MF-2, Fig. 2B) microfacies. Ooidal grainstone (MF-3, Fig. 2C) microfacies deposited in tidal bars with high energy is fairly limited throughout the all sections. Ostracod-dominated tidal-flat carbonates are widespread in shallow-water platform carbonates and also ostracod fragments are present varying rates (1-25%) almost in all microfacies types.

Table 1. Microfacies of Carbonate Rocks, characteristics, energy and comparison with standard microfacies, [6]

MF Type	Name	Characteristics		Paleoenvironment	Energy	Standart Microfacies (Flügel, 2004)
MF-1	Laminated-fenestral Mudstone	Micrite matrix, spar-filled irregular fenestrae and birdeyes. Geopetal fabric and lamination. Scattered scarce ostracod (%1), bioclasts (%3). Locally common only mudstone microfacies.	**Tidal-Flat**	Supratidal Intertidal	low energy	SFT-25 (FZ-9)
MF-2	Ostracod-fenestral Packstone-Wackestone/ Mudstone	Micrite matrix, common ostracod and ostracod fragments (%25-8). Spar-filled irregular fenestrae and stylolites. Scattered bivalve fragments, miliolids, dasycladacean algae, gastropods and cyanobacteria. Some levels including common intraclasts characterized by ostracod-inraclast wackestone-packstone and ostracod packstone microfacies.	**Tidal-Flat**	Intertidal ponds	low energy	SFT-21 (FZ-9)
MF-3	Ooidal Grainstone	Sparite matrix. Characterized by common concentric ooid grains (%60). Micrite-nuclei ooids and bivalve-nuclei (stretched) ooids. Other grains in the matrix are scarce benthic foraminifers and peloids. Very limited.	**Tidal-Flat**	Tidal ooid bars	high energy	SFT-15 (FZ-9)
MF-4	Peloidal/intraclastic Packstone-Grainstone	Micrite/sparite matrix. Intraclasts and peloids are (%50-60) predominant. This is accompanied by benthic foraminifers, locally common miliolids, ostracod and bivalve fragments, dasycladacean algae respectively. Some thin sections also include extraclasts. Very abundant and common.	**Protected Lagoon-Subtidal**	Intertidal Shallow subtidal lagoon	low to high energy	SFT-16-17 (FZ-8)
MF-5	Dasycladacean Algal Packstone-Wackestone	Micrite, locally sparite matrix. This texture is characterized by diverse dasycladacean algae (%8-20) and locally irregular spar-filled fenestrae. Scattered benthic foraminifers and bivalve and ostracod fragments.	**Protected Lagoon-Subtidal**	restricted shallow lagoon	low to moderate energy	SFT-18-DASY (FZ-7-8)
MF-6	Bioclastic Packstone-Wackestone	Micrite matrix, common uncertain and mostly bivalve shells bioclasts (%40-10). Spar-filled laminoid and irregular fenestrae. Geopetal fabric and stylolites. Fragments of ostracod, dasycladacean algae, intraclasts/peloids, rare gastropod and benthic foraminifers are other grains.	**Protected Lagoon-Subtidal**	restricted shallow lagoon	low energy (intermittently agitated)	SFT-12 (FZ-8)
MF-7	Benthic foraminiferal-intraclastic Packstone-Grainstone	Micrite/sparite matrix. Characterized by common benthic foraminifers (%25-20), intraclasts (%25-15), large bivalve fragments. Other grains in the matrix are miliolids and ostracod fragments.	**Protected Lagoon-Subtidal**	shallow subtidal lagoon	low to high energy	SFT-18-FOR (FZ-7-8)

3.2 Protected lagoon-subtidal settings

Restricted lagoon-subtidal shallow-water platform carbonates are composed of peloidal/intraclastic packstone-grainstone (MF-4, Fig. 2D-E), dasycladacean algal packstone-wackestone (MF-5, Fig. 2F), bioclastic packstone-wackestone (MF-6, Fig. 2G) and benthic foraminiferal-intraclastic packstone-grainstone (MF-7, Fig. 2H) microfacies. The first microfacies and also the most common in all sections is peloidal/intraclastic packstone-grainstone deposited in shallow subtidal lagoon and also intertidal environments. The second is characterized by diverse dasycladacean algae including *Salpingoporella annulata*, *Salpingoporella dinarica*, *Salpingoporella pygmaea*.

The third is dominated by mostly bivalve shells bioclasts and accompanied by ostracod fragments, dasycladacean algae, intraclasts, rare gastropods and other grains. The last microfacies consists of mainly common benthic foraminifera including *Praechrysalidina infracretacea*, *Orbitolinopsis capuensis*, locally abundant miliolids and intraclasts.

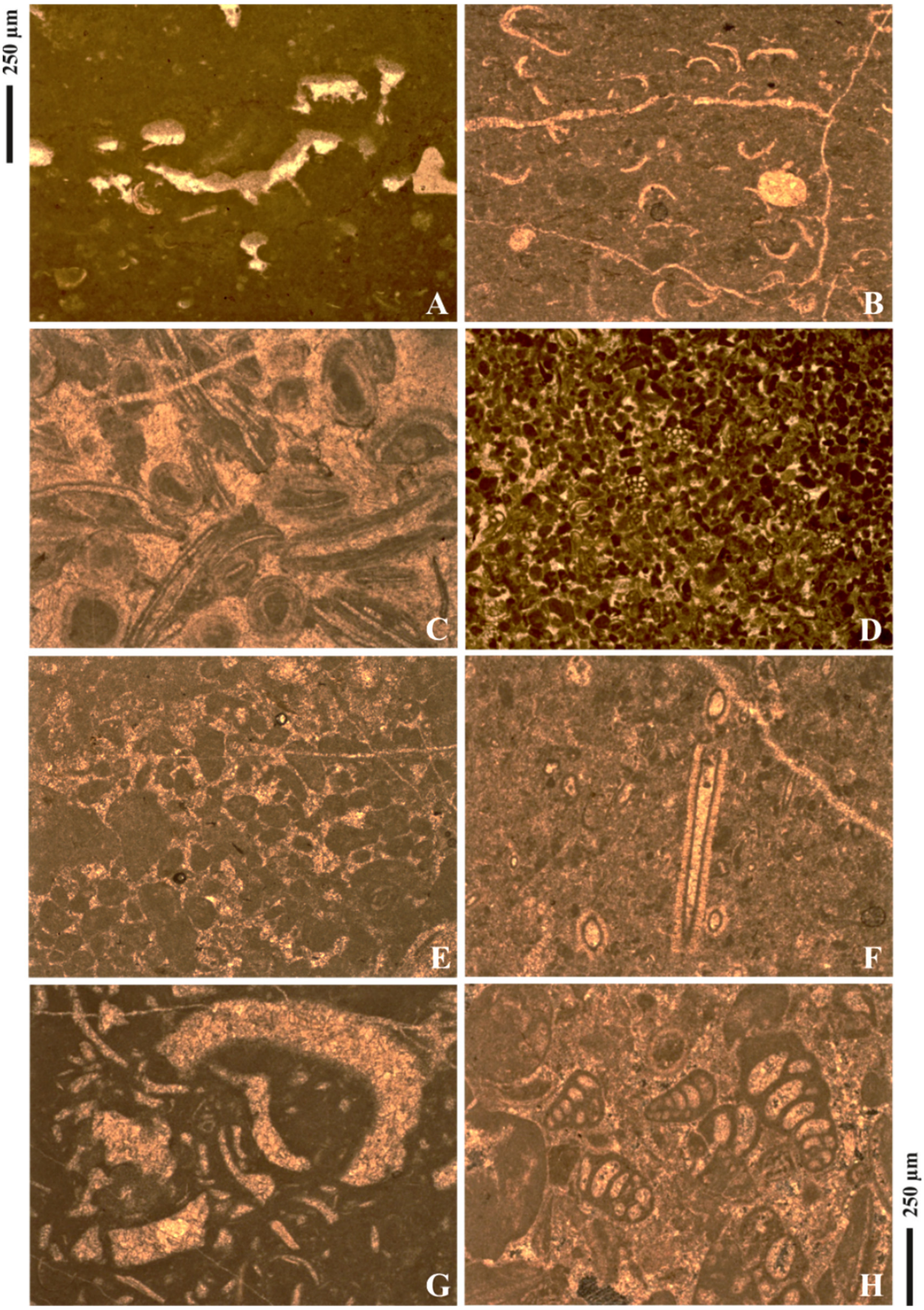

Figure 2. Microfacies of the Bolkar Mountains. A) Laminated-fenestral mudstone, MF-1, B) Ostracod-fenestral wackestone, MF-2, C) Ooidal grainstone, MF-3, D-E) Peloidal/intraclastic grainstone, MF-4, F) Dasycladacean algal wackestone, MF-5, G) Bioclastic packstone, MF-6, H) Benthic foraminiferal-intraclastic grainstone, MF-7

4. Conclusions

- All samples collected from five measured stratigraphic sections of the Bolkar Mountains have been studied and total seven different microfacies types have been described in this study.
- The sedimentological data, facies/microfacies and micropaleontological analysis of the carbonates of the Bolkar Mountains show that Early Cretaceous platform carbonates of the Bolkar Mountains deposited under a tidally affected tidal-flat and restricted lagoon conditions.
- The microfacies/facies studies also show that while dolomitization were dominate in the Berriasian-Valanginian, in the Hauterivian-early Aptian the effect of dolomitization largely disappeared and inner platform conditions still prevailed.

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