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The Sedimentological and Paleontological Features of Lutetian-aged Yeşilyurt Group at the Yeşilyurt - Gündüzbey Area (Malatya, Turkey)

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Abstract: The stratigraphic sequence in the study area starts with Carboniferous-Triassic the Malatya Metamorphics, which are composed of marble and schist, covered unconformably by the Maastrichtian Gündüzbey Group. The Group includes Kızılgüney Formation with conglomerate and sandstones, and Kapullu Formation containing limestone-marl alternations, with turbiditic sandstone intercalations. The sequence continues with the Lutetian Yeşilyurt Group includes Zorbon, Yukarıbanazı and Gedik Formations, overlying unconformably the Kapullu Formation. The Zorbon Formation is composed of conglomerate interbedded with sandstone and mudstone while the Yukarıbanazı Formation consists of sandstone and shale alternation with intercalations of conglomerates and olistolithes. The Gedik Formation is composed of reefal limestone, claystone and marl, and underlies as unconformably the Pliocene Beylerderesi Formation including conglomerate interbedded with sandstone. The Quaternary alluvium unconformably overlies all the units in the region. Early dolomitization occurred as disseminated in the Gedik Formation.

Keywords: Sedimentology, Lutetian, Yeşilyurt, marine, reef, basin

Yeşilyurt-Gündüzbey (Malatya, Türkiye) Çevresindeki Lütesiyen Yaşlı Yeşilyurt Grubunun Sedimantolojik ve Paleontolojik Özellikleri

Özet: Çalışma alanındaki stratigrafik istif mermer ve şistten ibaret Karbonifer-Triyas yaşlı Malatya metamorfikleri ile başlar ve Maastrihtiyen yaşlı Gündüzbey grubu tarafından uyumsuzlukla örtülür. Gündüzbey grubu, konglomera ve kumtaşından oluşan Kızılgüney formasyonu ile türbiditik kumtaşı arakatkılı kireçtaşı-marn ardalanmasından oluşan Kapullu formasyonundan ibarettir. İstif, Kapullu formasyonunu uyumsuzlukla örten Zorbon, Yukarıbanazı ve Gedik formasyonlarını içeren Lütesiyen yaşlı Yeşilyurt grubu ile devam eder. Zorbon formasyonu konglomera aratabakalı kumtaşı ve çamurtaşından oluşurken, Yukarıbanazı formasyonu olistolit ve konglomera arakatkılı kumtaşı-şeyl ardalanmasından oluşmaktadır. Gedik formasyonu resifal kireçtaşı, kiltaşı ve marndan ibarettir ve kumtaşı aratabakalı Pliyosen yaşlı Beylerderesi formasyonu tarafından uyumsuzlukla üstlenir. Kuvaterner yaşlı alüvyon bölgedeki kendisinden yaşlı bütün birimleri uyumsuz olarak örter. Gedik formasyonunda saçınımlı olarak erken dolomitleşme gelişmiştir.

Anahtar kelimeler: Sedimantoloji, Lütesiyen, Yeşilyurt, denizel, resif, havza

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1. Introduction

Turkey is an essential component of the Alpine–Himalayan orogenic system. It includes a number of continental blocks separated by suture zones, formed by the closure of the various branches of the Neo-Tethyan ocean during the late Cretaceous to Eocene. The study area is located between Yeşilyurt-Konak towns, Malatya, Eastern Turkey (Fig. 1), where Carboniferous to Quaternary-aged stratigraphic units crop out (Fig. 2, 3).

The Yeşilyurt Group in the study area shows spread starting Gündüzbey environments to north-northeast and northwest (Fig. 2). The Yeşilyurt Group which older units than himself covered unconformably was named and divided the 5 formation. Özkan [1,2] analyzed a paleontologic study dividing 3 formation. In this study, were investigated sedimentologic features of the Yeşilyurt Group which divided 3 formations. Lutetian-aged shaped reefal complex the Yeşilyurt Group consist of reef core, lagoon, fore-reef, basen deposits and developed often channels.

Figure 1: Map of location study area **(**Google Earth view).

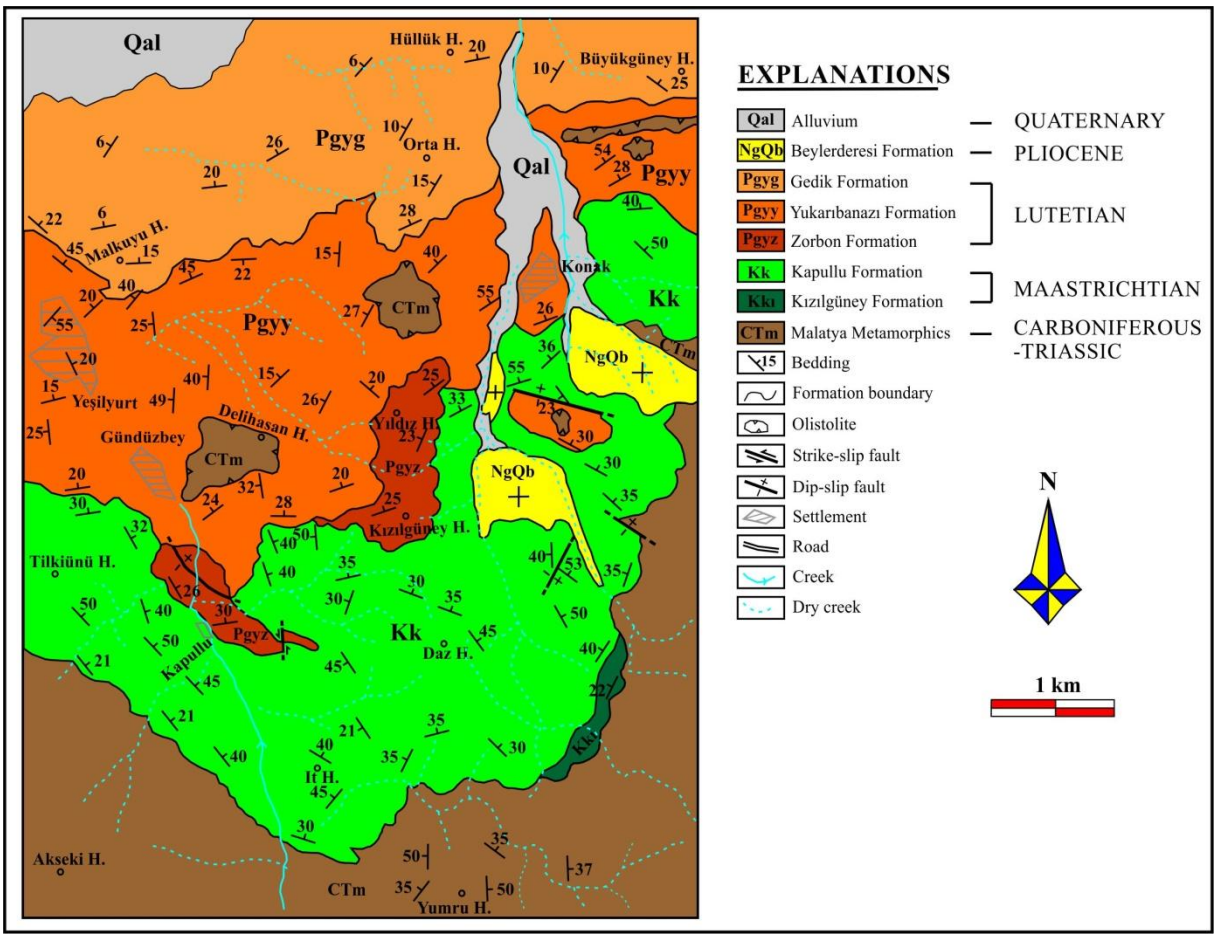

Figure 2: Geological map of the study area [1].

1. Sedimentology

In this section, those will explain the Zorbon Formation (shallow marine environment) occurred basal conglomerate of the Yeşilyurt Group, the Yukarıbanazı Formation (deep marine environment) formed from sandstone-shale alternation and the Gedik Formation shaped reefal complex (shelf environment).

1.1. Zorbon Formation

The Zorbon Formation crops out in the narrow range south of Gündüzbey town Kapullu, Kızılgüney and Yıldız Hills environs (Fig. 2, 4). The unit was named Zorbon Conglomerate by Önal et al. [3], but in this study it was named as the Zorbon Formation. The Zorbon Formation is represented by red to gray colored, medium-thick bedded, thin to coarse grained, rough graded, interbedded sandstone and mud, poorly sorted, and calcite cemented. The Zorbon Formation contains *Nummulites* sp. and *Assilina* sp. in its matrix (Fig. 5). Gravels of polygenetic originated conglomerates occur mostly than marble and schist, as lesser micritic limestone and reefal limestone.

Contained as interbedded sandstone is occurred red-gray colored, thin-coarse grained, medium to thick bedded and calcite cemented. Again, contained as intercalated mudstone is formed red colored, medium to thick bedded and soft property.

The Zorbon Formation overlies unconformably Maastrichtian-aged the Kapullu Formation and, the Yukarıbanazı Formation is overlained conformably by the Lutetian-aged Yukarıbanazı Formation.

The Zorbon Formation contains fossils such as *Assilina* cf. *exponens*, *Assilina* cf. *aspera*, *Nummulites* cf. *millecaput*, *Discocyclina* sp., *Asterocyclina* sp., *Archaelithothamnium* sp., *Lithophyllum* sp., Bryozoa and Bivalvia according to these fossils were given to the Zorbon Formation Lutetian-age.

According to features of lithological and paleontological the Zorbon Formation was deposited a braided river to shallow marine environment during Lutetian transgression.

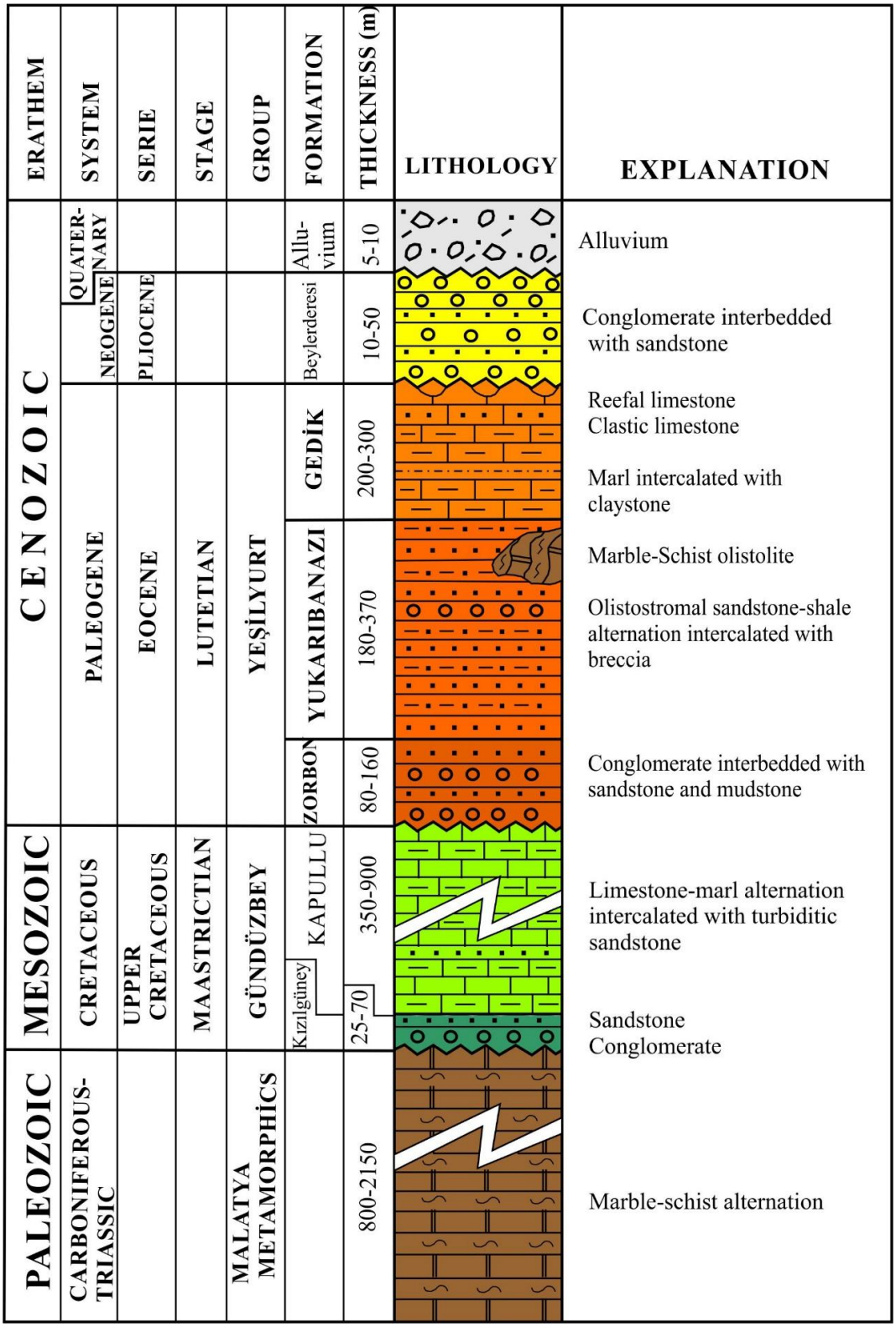

Figure 3: Generalized columnar section of the study area [1, 2].

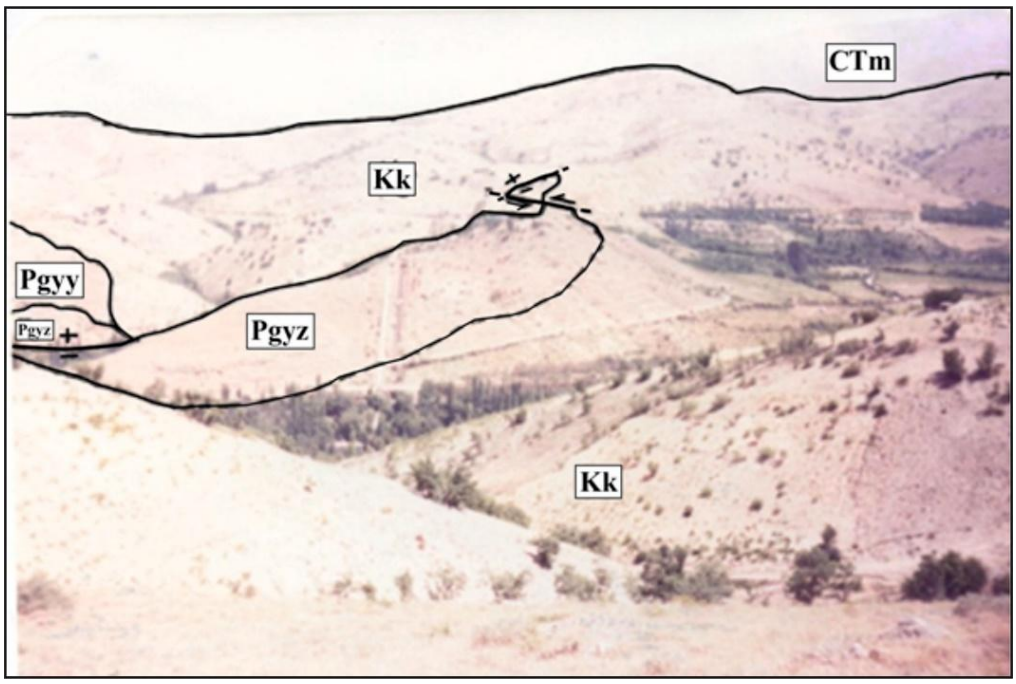

Figure 4. The Kapullu Formation (Kk) and the Zorbon Formation (Pgyz) boundary relationship. Pgyy: the Yukarıbanazı Formation, CTm: the Malatya Metamorphics (Tilkiünü Tepe'den Doğu'ya bakış) [1].

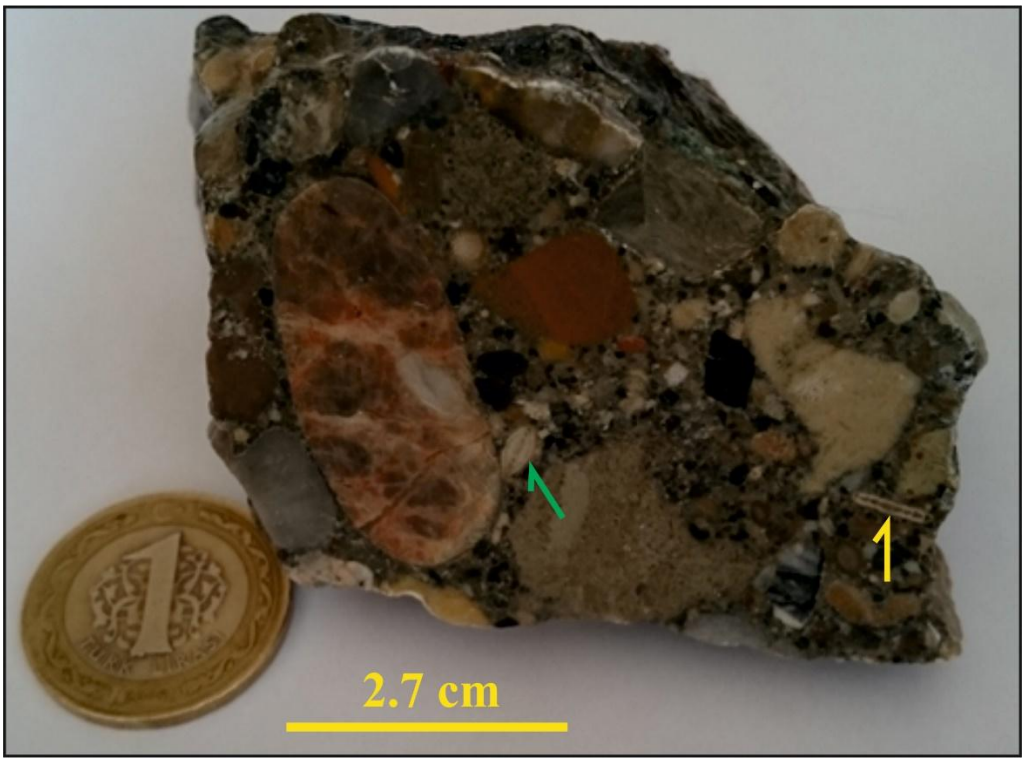

Figure 5. Observed *Nummulites* sp. (green arrow) and *Assilina* sp. (yellow arrow) in the matrix of Polygenic conglomerates in the Zorbon Formation [1].

1.2. Yukarıbanazı Formation

The Yukarıbanazı Formation is shaped a belt as extensioned east-west along Yeşilyurt-Gündüzbey-Konak (Yukarıbanazı) centers. The unit occurred sandstone and shale alternation with intercalated conglomerates was named by Önal et al. [3].

The Yukarıbanazı Formation consists of gray colored sandstone and shale alternation (Fig. 6) with intercalated conglomerates and olistolithes (marble and schist). The olistoliths were formed in the before Lutetian by tectonic events, and moving to the basin under the influence of gravity have caused to acquire a olistostromal feature of the Yukarıbanazı Formation. included as intercalated conglomerates in the Yukarıbanazı Formation are gray colored, medium to thick bedded, cemented calcite, normal graded (Fig. 7) and poorly sorted. Gravels of polygenic conglomerate are formed mostly marble-schist, a small amount of limestone and magmatic rock fragments.

Gray, greenish gray sandstones are polygenic, grained thin to coarse, cemented calcite, thin to medium and thick bedded, and have parallel lamination (Fig. 8a), flute casts (Fig. 8b), groove casts (8c), graded bedding and ripples.

Light green-greenish gray colored shales are thin bedded in lower levels, medium to very thick bedded up to the highest level (Fig. 9), and laminated in the some levels. Shale unit is ductile, and contains abundant planktic Foraminifera such as *Globigerina senni*, *Acarinina bulbrooki*, *Truncorotaloides topilensis*, *Globigerinatheka index index*, *Globorotalia* sp. and Rotaliidae.

Figure 6. Sandstone-shale alternation in the Yukarıbanazı Formation [1]. Scale (hammer size) is 28 cm.

Figure 7. Conglomerate with graded bedding in the Yukarıbanazı Formation [1]. Scale (hammer size) is 28 cm.

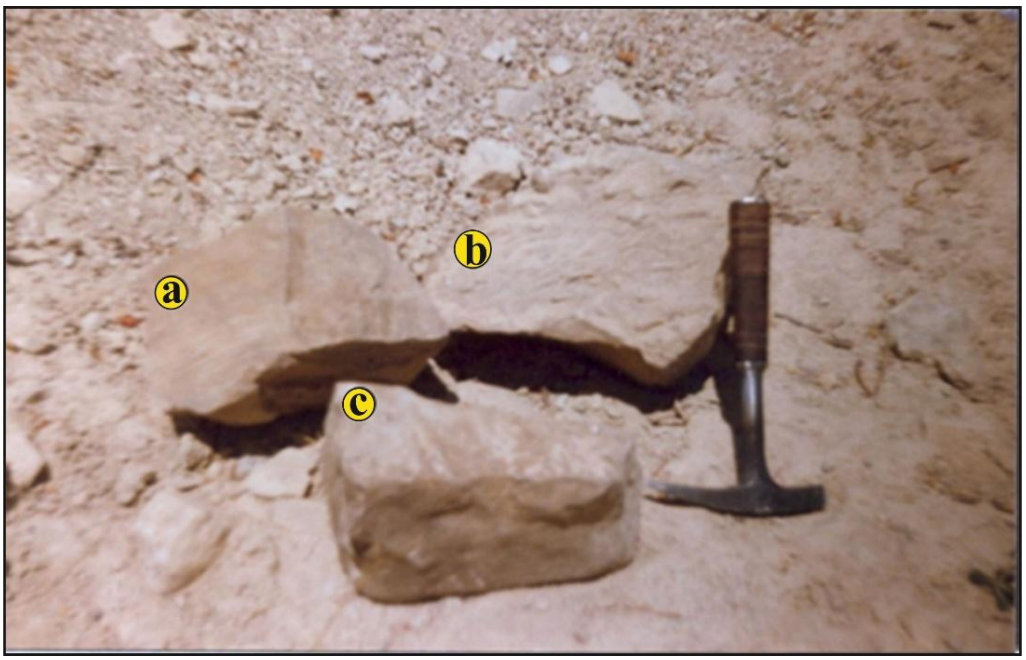

Figure 8. Lamination (a), flute cast (b) and groove structure (c) in the Yukarıbanazı Formation [1]. Scale (hammer size) is 28 cm.

The channel fill on which 15 meter width and 5 meter thickness was observed in the Yukarıbanazı Formation in northern of Delihasan Hill. Gray colored, poorly sorting, mostly gravelled marble-schist in the unit was observed the sandstone blocks which belong to Yukarıbanazı Formation. Furthermore, folding was observed to cause by marble-schist olistoliths in the Yukarıbanazı Formation in northeast of Delihasan Hill. This situation was also observed located in the locality of olistoliths in south the Büyükgüney Hill in northeast of Konak town.

Figure 9. Alternation of sandstone-shale and thin-very thickness bedded shale in the Yukarıbanazı Formation [1]. Scale (hammer size) is 28 cm.

The Yukarıbanazı Formation overlies conformably Lutetian-aged the Zorbon Formation and unconformably Kapullu Formation. The Yukarıbanazı Formation is overlained conformably by the Lutetian-aged Gedik Formation.

The Yukarıbanazı Formation contains *Globigerina senni*, *Pseudohastigerina micra*, *Acarinina bulbrooki*, *Truncorotaloides topilensis*, *Globigerinatheka index index*, *Nummulites* cf. *millecaput*, *Assilina* cf. *aspera*, *Assilina* cf. *exponens*, *Assilina* cf. *spira*, *Gyroidinella magna*, *Sphaerogypsina* sp., *Gypsina* sp., *Linderin*a sp., *Fabiania* sp., *Discocyclina* sp., *Asterocyclina* sp., *Planorbulina* sp., *Alveolina* sp., *Orbitolites* sp., *Lockhartia* sp., *Textularia* sp., Miliolidae, Echinodermata, Bryozoa, Algae (Fig. 10) and according to these fossils assemblages suggesting a Lutetian age.

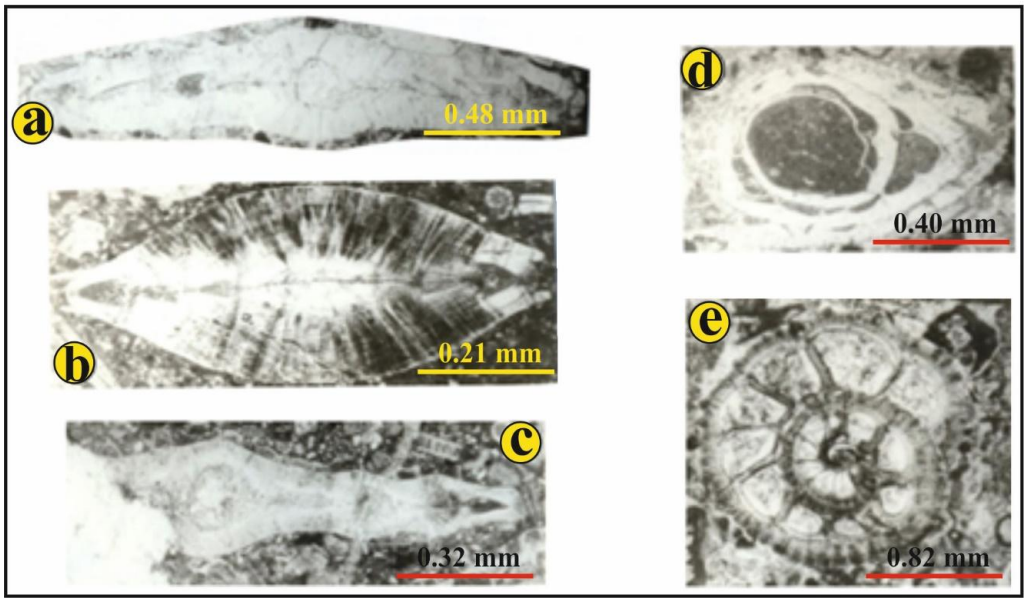

Figure 10. Some benthic foraminiferas of the Yukarıbanazı Formation. a) *Assilina* cf. e*xponens*, b) *Assilina* cf. *aspera*, c) *Assilina* cf. *spira*, d) *Nummulites* cf. *millecaput*, e) *Gyroidinella magna*.

Yukarıbanazı Formation was formed with turbid currents deep section of Lutetian-sea.

1.3. Gedik Formation

Observed as extensioned east-west along Malkuyu Hill, Orta Hill and Büyükgüney Hill the Gedik Formation is occurred reef core, lagoon, fore-reef deposits and developed often channel, and was named by Önal et al., [3]. Three stratigraphic sections positioned correctly fossil was measured from the Gedik Formation (Fig. 11).

Light gray–beige colored the Gedik Formation is made up of coral-algal frameworked reef core, lagoon and fore-reef, and has dissolution cave (Fig. 12, 13).

Reefal limestone is massive and porous while lagoon deposits are medium to very thick bedded marls, with plenty of Miliolidae fossiliferous. The fore-reef clastic limestones are medium to thick bedded with plenty of benthic Foraminifera. The miliolids are observed at the biomicritic limestone of the Gedik Formation (Fig. 13d). Greenish-yellow claystone is intercalated with limestones, which thin to medium layered and soft.

The Gedik Formation overlies conformably Lutetian-aged the Yukarıbanazı Formation. The Gedik Formation is overlained unconformably by the Pliocene-aged Beylerderesi Formation.

Bioclastic limestone (Fig. 14) belonging to the Gedik Formation which is lateral-vertical transition with basin deposites, and includes such as *Nummulites* cf. *millecaput*, *Assilina* cf. *exponens*, *Halkyardia minima*, *Orbitolites* sp., *Alveolina* sp., *Asterigerina* sp., *Rotalia* sp., *Gypsina* sp., *Sphaerogypsina* sp., *Fabiania* sp., *Gyroidinella* sp., *Textularia* sp., Miliolidae and Calcarinidae.

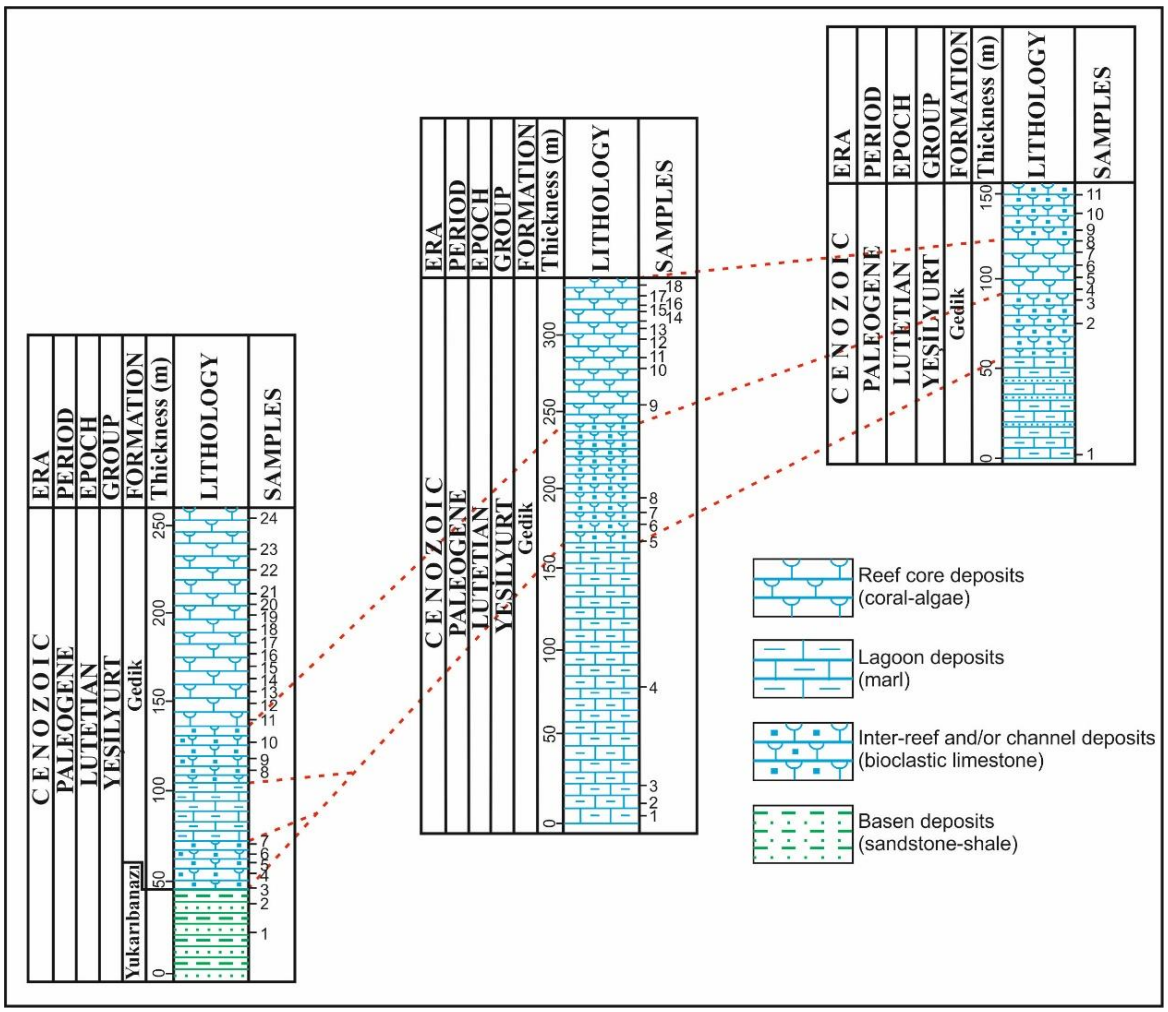

Figure 11. Correlation of measured stratigraphic section of the Gedik Formation.

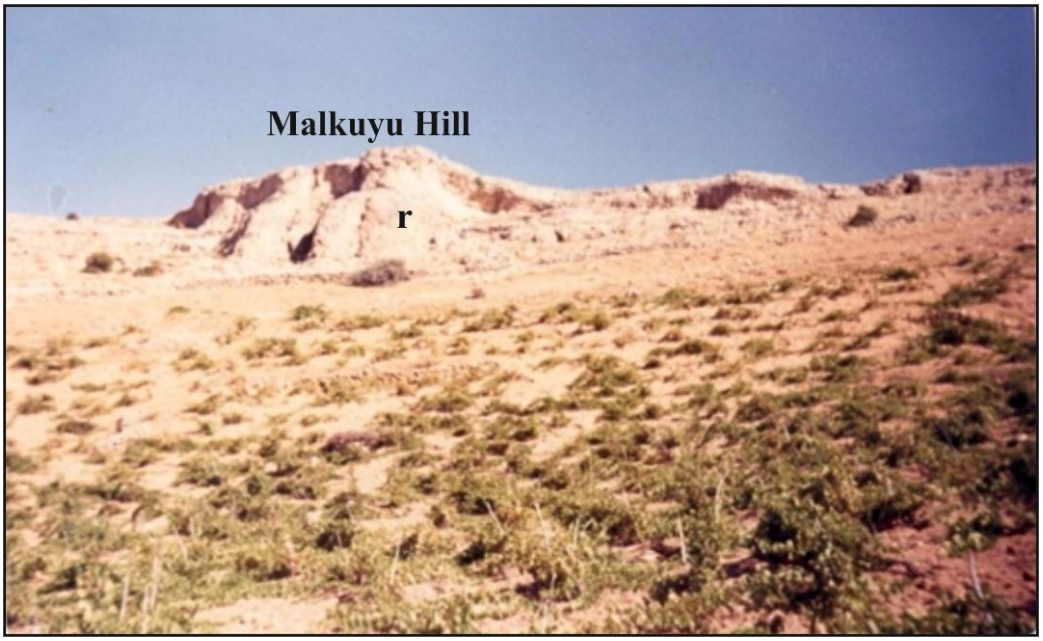

Figure 12. Massive reef core (r) of Gedik Formation [1].

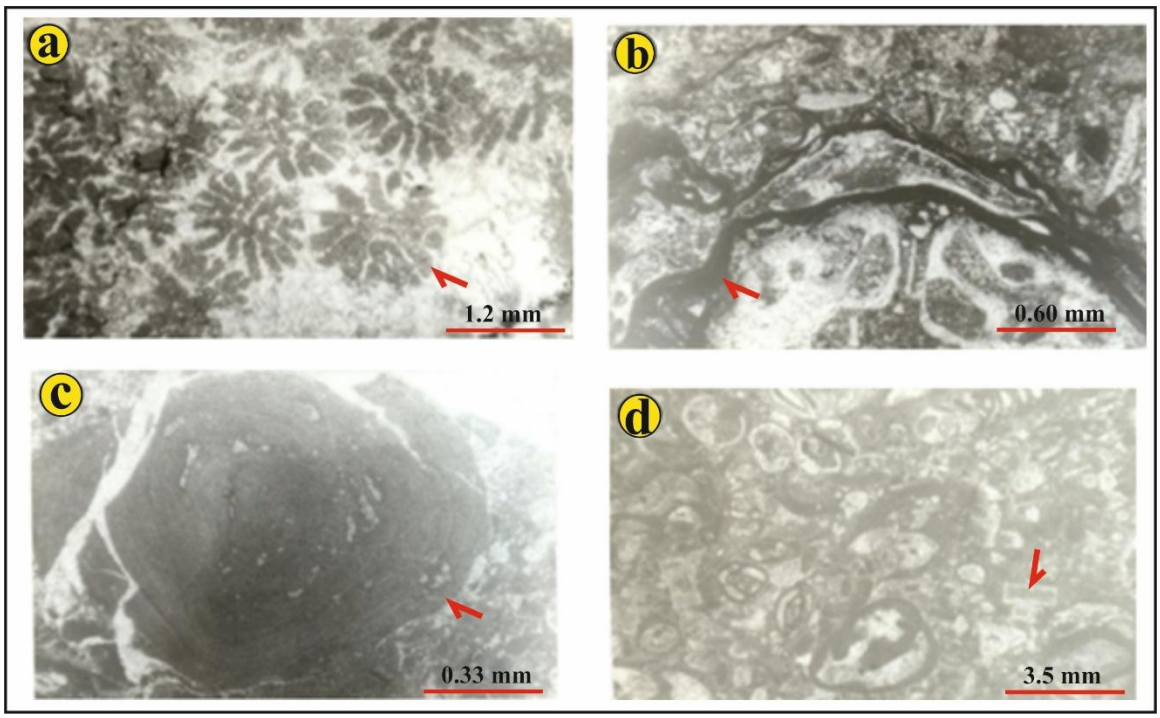

Figure 13. Reefal the Gedik Formation coral-algae togetherness. a) coral (arrow), b) corallin algae (arrow), c) corallin algae (arrow), d) dolomite romboedr (arrow) in biomicritic limestone.

Figure 14. Bioclastic limestone of the Gedik Formation [1]. Scale (Jacop stick size) is 1.5 meter.

The Gedik Formation contains fossils such as *Chapmanina gassinensis*, *Nummulites* cf. *millecaput*, *Assilina* cf. *exponens*, *Eoannularia eocenica*, *Sphaerogypsina globulus*, *Fabiania cassis*, *Halkyardia minima*, *Gyroidinella magna*, *Silvestriella* cf. *tetraedra*, *Linderina brugesi*, *Opertorbitolites* sp., *Orbitolites* sp., *Asterigerina* sp., *Rotalia* sp., *Lockhartia* sp., *Operculina* sp., *Planorbulina* sp., *Gypsina* sp., *Discocyclina* sp., *Aktinocyclina* sp., *Asterocyclina* sp., *Textularia* sp., *Pyrgo* sp., *Triloculina* sp., *Spirolina* sp., Peneroplinae, Miliolidae, Bivalvia, Gastropoda, Echinodermata, Bryozoa, Coral, Algae (Fig. 15), and according to these micropaleontological assemblage suggest a Lutetian age of Gedik Formation.

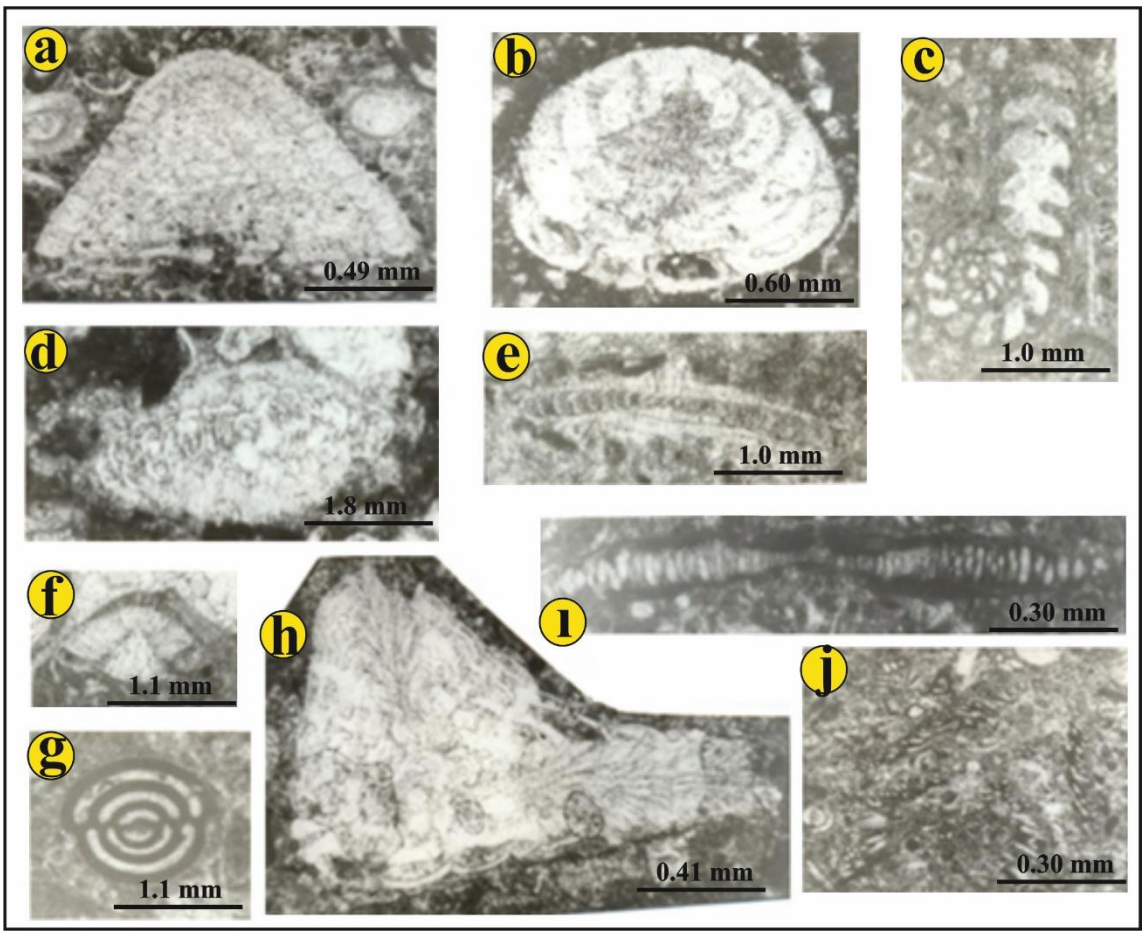

Figure 15. Some fossils of the Gedik formation [1]. a) *Chapmanina gassinensis*, b) *Lockhartia* sp. c) *Spirolina sp*., d) *Linderina brugesi*, e) *Eoannularia eocenica*, f) *Halkyardia minima*, g) Pyrgo sp., h) *Silvestriella* cf. *tetraedra*, ı) *Opertorbitolites* sp., j) *Fabiania cassis*.

According to features of lithological and paleontological the Gedik Formation was deposited a reefal complex (reef core, lagoon and fore-reef) environment.

2. Discussion

The Zorbon Formation of Yeşilyurt Group is developed as red-gray colored conglomerate, and intercalated sandstone and mudstone in shallow-marine to continental (braided stream) environment passing-zone (Fig. 16). Red colored fossil-free zones are symbolized, gray colored with benthic foraminifera zones are characterized in shallow marine environment. The pretty good to be rounded pebbles of the conglomerate pointed out long distance transport. Having polygenic conglomerate origin is expressed to be many different lithologies in the source range.

The Yukarıbanazı Formation of the Yeşilyurt Group starting formation the Lutetian transgression in deep marine environments (Fig. 16) incluing conglomerate channel fill sandstone-shale alternation (in flysch feature) as it developed; also comprised in the some marble-schist olistolithes and sandstone blocks to belong the Yukarıbanazı Formation is expressed to become olistostromal feature (and/or wild-flysch) of the Yukarıbanazı Formation.

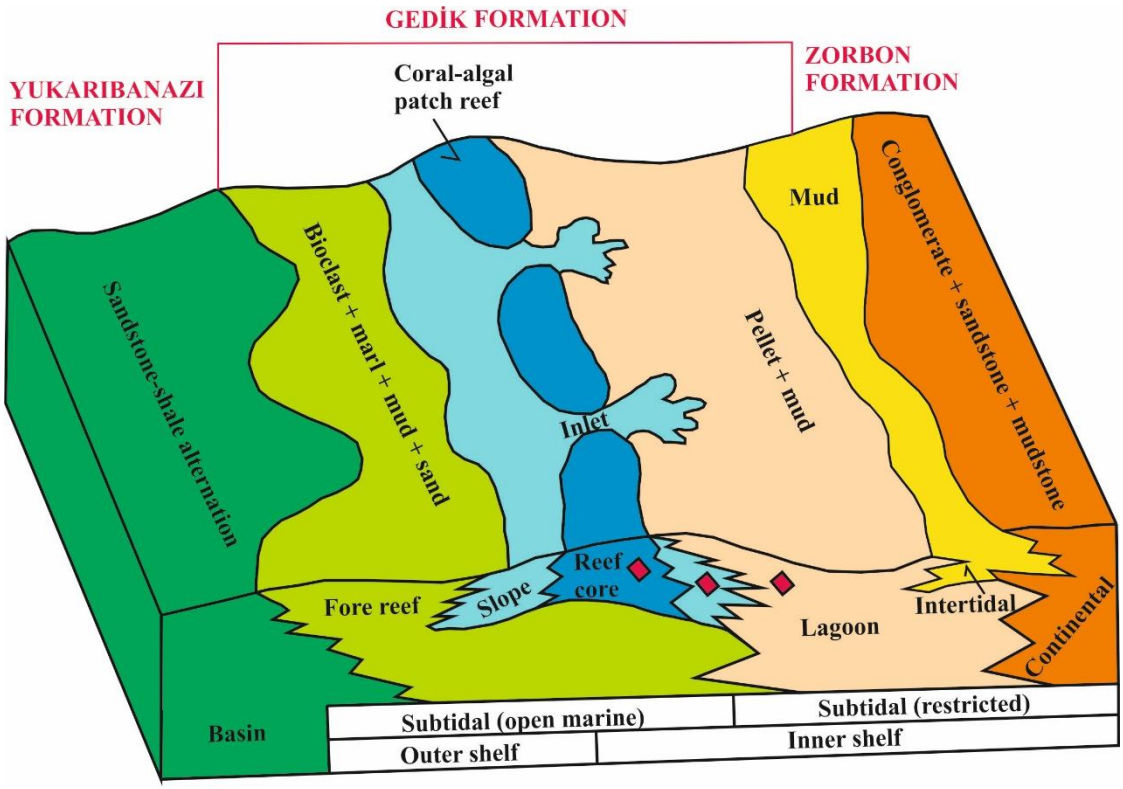

Figure 16. Block diagram of the distribution of the Yeşilyurt Group (Zorbon, Yukarıbanazı and Gedik Formations) depositional environments (modified after Reeckmann and Friedman [4]).

Sandstones of the Yukarıbanazı Formation at the base of obsrved flute and groove casts, and into laminations, graded and ripples are supported this opinion.

The Gedik Formation of Yeşilyurt Group developed to shape reefal complex (back-reef/lagoon, reef core and fore-reef) in shallow marine (Fig. 16) environment (shelf) pointed out in turned regression of developed Lutetian transgression in region. The small sized coral-algal framework of reef core is showed to develop reefs of the Gedik Formation shaped patch reef in shelf range. Observed Plenty of miliolids and peneroplid and of bioclastic-pelleted canal filling in back-reef units of the Gedik Formation are expressed the lagoon environment in the landward side of the shelf and/or inter-reef range. Again, observed plenty of benthic Foraminifera (such as fossils *Nummulites*, *Assilina*, *Discocyclina*) in the Gedik Formation to symbolize the fore-reef environment.

It is considered that, observed disseminated dolomite rhombs in the Gedik Formation limestones during precipitation or immediately dolomitized the diagenetic process of limestones by the contribution Mg provided than seawater and/or dolomitized depending on sea level the change partly as a result of meteoric water-marine water mixing. Many authors [5] was discussed the marine and/or mixing-zone dolomitization no associated with evaporites in the Taurus belt. The only major source of magnesium for penecontemporaneous and shallow-burial dolomitization may be seawater [6,7]. The meteoric-marine mixing zone model has been popular for cases where there are no evaporites associated with the dolomites, subtidal facies are dolomitized, and the dolomitization event was relatively early [8].

The Yeşilyurt Group is overlained unconformably by the Pliocene-aged Beylerderesi Formation, that this state pointed out no any deposited during Late Eocene-Late Miocene.

3. Conclusions

The Zorbon Formation was formed in the braided and shallow marine environment conditions.

The Yukarıbanazı Formation was occurred as wild-flysch in the deep marine environment.

The Gedik Formation was formed that shaped reefal complex (back-reef, reef core, fore-reef) as consisting patch reef in the shallow marine environment (shelf environment).

Observed dolomites in the Gedik Formation was occurred as early diagenetic (simultaneous and/or shallow-burial) from marinewater and/or marinewater-meteoricwater at the mixing-zone.

The Yeşilyurt Group has completed the development started as transgressive, and as regressive, and it has eroded duration Late Eosen to Late Miocene.

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