

Sedimentary Evidences for the Depositional and Environmental Changes Regarding to Regression during Mid to Late Miocene in the Neogene Adana Basin (Southern Turkey)

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Abstract

In this study we investigate sedimentary and stratigraphic characteristics of the Mid to Late Miocene deposits to better understanding of the Tertiary evolution of the Adana Basin (Southern Turkey). For this purpose, detailed mapping, sedimentary survey and interpretations were made considering the stratigraphic relations in the Middle-Late Miocene units in the region. The depositional evolution of the Adana Basin starts during the Early Miocene as a foreland basin within the Çukurova region. An extensive marine transgression during the Early Miocene commenced the filling of the basin. The pre-Miocene deposition area was a large platform with an adjacent depression area. This depositional environment widely controlled the Miocene sedimentation after the Aquitanian-Burdigalian transgression. The Miocene sequences in the Adana Basin were deposited due to the northward transgression. The northerly sourced deltaic and littoral-brackish Kaplankaya Formation and a slightly deeper reefal Karaisalı Formation were deposited in the areas close to the shore. Documented by shallow to deeper marine sedimentation, the marine inundation of the region occurred during Aquitanian-Burdigalian and continued into the Serravallian causing the former coastline to migrate north. Synchronously tectonic subsidence further south cause southward progressive deepening. Therefore, various facies types, ranging from deep marine turbidites to terrestrial, deposited in the basin. The northern margin of the basin was experienced normal faulting in consequence of progressive tectonic and subsidence events during this marine transgression in the Langhian-Serravallian.

Mapped and interpreted within three facies types, Güvenç Formation include; i) deep marine sediments, ii) offshore sediments and iii) shallow marine sediments. Deep sea deposits were accumulated in the early stages of the Early-Middle Serravallian period in the deeper part of the basin. During the Mid-to Late Serravallian offshore sediments were deposited in the southern parts of the basin. Further south, due to the continued regression, the shallow marine sediments were deposited in the basin during the Serravallian. Related to the neotectonic period of Anatolia, the transgressive sequences deposited within the basin were tilted during Late Serravallian to Early Tortonian period. The marine regression towards the south was accompanied by tectonic re-organisation in the Early Tortonian. Consequently, regressive sequences of the Tortonian age, the Kuzgun member of Kuzgun Formation, which involve shallow marine (beach) sediments and meandering river deposits are resting on the tilted Güvenç Formation with low angle unconformity.

Keywords: Adana basin, Neogene sediments, Transgression, Regression

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Neojen Adana Havzasında Orta-Geç Miyosen Sırasında Meydana Gelen Regresyona Bağlı Olarak Gelişen Çökelim ve Ortamsal Değişiklikler ile İlgili Sedimanter Kanıtlar (Güney Türkiye)

Öz

Bu çalışmada, Adana havzasının (Güney Anadolu) Tersiyer evriminin daha iyi anlaşılmasına katkı sağlamak amacıyla Orta-Geç Miyosen çökellerinin detay sedimanter ve stratigrafik özellikleri araştırılmıştır. Bu amaçla, bölgede Orta-Geç Miyosen birimlerinin stratigrafik ilişkileri gözetilerek detay haritalama ve sedimanter log alımı ve yorumlaması yapılmıştır. Adana Havzasının sedimanter evrimi, Erken Miyosen döneminde Çukurova bölgesinde bir ön havza olarak başlamaktadır. Havzanın oluşumu, Erken Miyosen sırasında büyük ölçekli bir denizel transgresyon ile başlamaktadır. Miyosen öncesi sedimantasyon alanı, Akitaniyen-Burdigaliyen transgresyonundan sonra Miyosen sedimantasyonunun gelişimini önemli ölçüde etkileyen, komşu bir çöküntü alanına sahip büyük bir platform konumundaydı. Bu çökeltme ortamı, transgresyon sonrasında Miyosen dönemindeki sedimantasyonu önemli ölçüde kontrol etmiştir. Havzadaki Miyosen çökelleri, kuzeye doğru ilerleyen bu transgresyon sonucunda gelişmiştir. Kıyıya yakın bölgelerde kuzey kaynaklı litoral-acı su ve deltayık karakterli Kaplankaya Formasyonu ve biraz daha derinde resifal Karaisalı Formasyonu depolanmıştır. Bölgeye zaman zaman ilerleyen su basmaları sonucu ortamın derinleşmesi Akitaniyen-Burdigaliyen dönemlerinde meydana gelmiş olup, Serravaliyen'e kadar devam etmiştir. Bu durum, eski sahil şeridinin havza sınırının kuzeye doğru ilerlemesine neden olmuştur. Daha güneyde eş zamanlı tektonik çökme, havzada güneye doğru ilerleyen bir derinleşmeye yol açmıştır. Sonuç olarak, havzada karasaldan derin deniz türbiditlerine kadar uzanan çok çeşitli fasiyes türleri çökelmiştir. Langiyen-Serravalliye'deki bu geçiş sırasında, Havzanın kuzey kenar kesimleri, ilerleyen tektonik, sedimantasyon ve çökme olaylarının bir sonucu olarak normal faylanma ile deforme olmuştur.

Güvenç Formasyonu; i) derin deniz sedimanları, ii) deniz kenarındaki sedimanlar ve iii) sığ deniz sedimanları olmak üzere 3 fasiyes tipine ayırılmış ve haritalanmıştır. Derin deniz sedimanları, Erken-Orta Serravaliyen döneminin erken evrelerinde havzanın derin kesimlerinde çökelmiştir. Orta-Geç Serravaliyen döneminde kıyı ötesi tortullar havzanın güney bölgelerinde depolanmıştır. Daha güneyde, devam eden regresyon nedeniyle, Serravaliyen'deki sığ deniz sedimentleri havzada çökelmiştir. Türkiye'nin neotektonik dönemi ile ilişkili olarak, havza içinde biriken transgresif birimler Geç Serravalliye-Erken Tortoniye döneminde eğim kazanmıştır. Erken Tortoniye döneminde, güneye doğru denizin geri çekilmesine yeni tektonik düzen eşlik etti. Böylelikle, menderesli nehir ve sığ deniz (plaj) çökellerini içeren Kuzgun Formasyonu'nun Kuzgun üyesi olan Tortoniye regresif istifleri, Güvenç Formasyonu üzerine düşük açılı uyumsuzlukla gelmektedir.

Anahtar Kelimeler: Adana havzası, Neojen çökelleri, Transgresyon, Regresyon

1. INTRODUCTION AND GEOLOGICAL FRAMEWORK

The Adana Basin occupies a structurally complex region in southern Anatolia, to the north of the Antioch triple junction, where the Afro-Arabian, Mediterranean and Anatolian plates meet, and is currently bounded by the sinistral Ecemiş Fault

zone in the west, the Taurus orogenic belt in the north, the Amanos Mountains and East Anatolian Fault Zone in the east. The Cenozoic evolution of the Eastern Mediterranean region is very complicated. Two major sedimentary basins (the Antalya and Çukurova basins) record the main events in southern Turkey during the later part of this epoch [1-3]. The major Çukurova Basin

comprises the Adana and İskenderun Basins, separated by the Misis structural high [2,4]. However, the Adana Basin probably extends to Cyprus underneath the Mediterranean in the south and has an approximate area of 10,000 square kilometres while main depocentre of the basin is between the Taurides and Adana City.

The Adana Basin originated as a peripheral foreland basin. This transition suggest that the sea had retreated south in the region by the late Oligocene. Evidenced by an angular unconformity between the Early Miocene terrestrial and shallow marine deposits of the Adana Basin and earlier formed Karsantı Basin deposits, region was displaying an irregular paleotopography at this

stage. Marine inundation of the region occurred during the mid Burdigalian evidenced by shallow to deeper marine deposition and continued into the Serravallian, causing the former coastline to migrate north. Simultaneous tectonic subsidence further south led to progressive deepening towards the south. Consequently, a great variety of facies types, ranging from terrestrial to deep marine turbidites, formed within the basin. During this marine transgression in the Langhian-Serravallian the northern margin of the basin was deformed by normal faulting as a result of progressive tectonic and subsidence events. The basin fill is both marine and non-marine in character, which shows a gradual transition at the northern margin of the basin one into another.

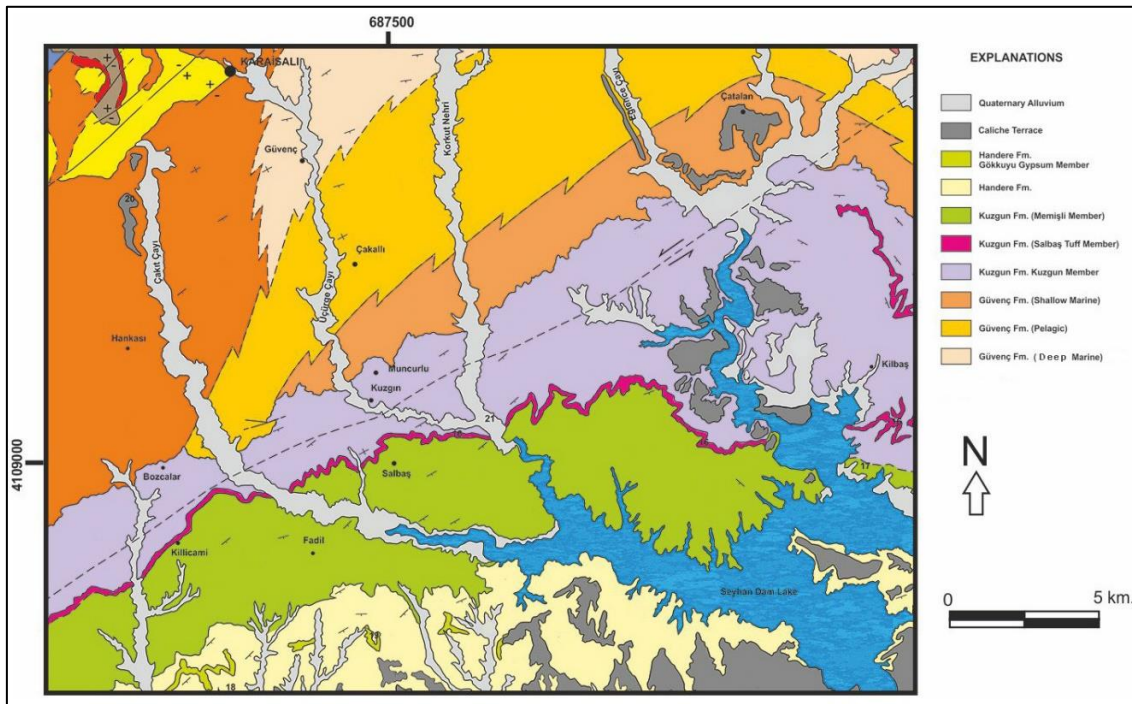


Figure 1. Geological map of southern part of the Karaisalı district of Adana including Neogene units of Adana basin mentioned in text

Gradual infilling of this deep basin ensued, with distinct shallowing upward character seen in the upper part of the Serravallian. During the Early Tortonian, southward marine retreat was accompanied by tectonic re-organisation. Thus, late Neogene regressive sequences succeeded the

marine sediments with a low angle unconformity. The sedimentary cycle associated with the major transgression of the Miocene sea includes the Kaplankaya, Karaisalı, Cingöz and Güvenç Formations, deposited during Aquitanian and Serravallian times (Figures 1, 2). The boundary

between Güvenç and overlying Kuzgun Formation represents a transition from transgressive to regressive deposition and has a low angle

unconformity in between that can be distinctly observed on the seismic profile (Figure 3).

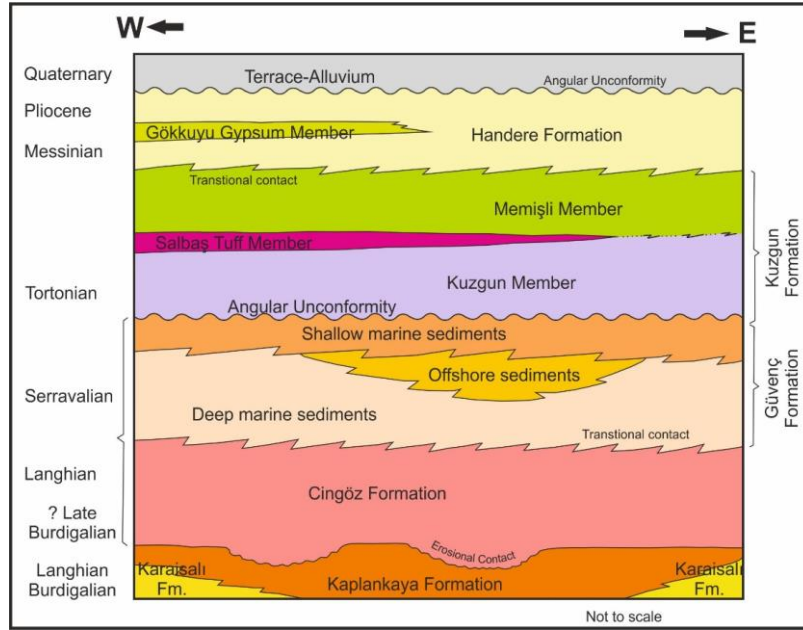


Figure 2. Schematized section showing contact relationships of Neogene formations of Adana Basin (redrawn from Ünlügenç, 1993 [3])

2. END OF TRANSGRESSIONAL CYCLE (GÜVENÇ FORMATION)

The last transgressive unit of Neogene Adana Basin, the Güvenç Formation is extensively developed at the east and southeast of Karaisali

district. According to the sedimentological and palaeontological attributes three informal members can be distinguished from bottom to top in the Güvenç Formation: (i) deep marine deposits cropping out around Güvenç village, east of Karaisali town, south of Nuhlu village.

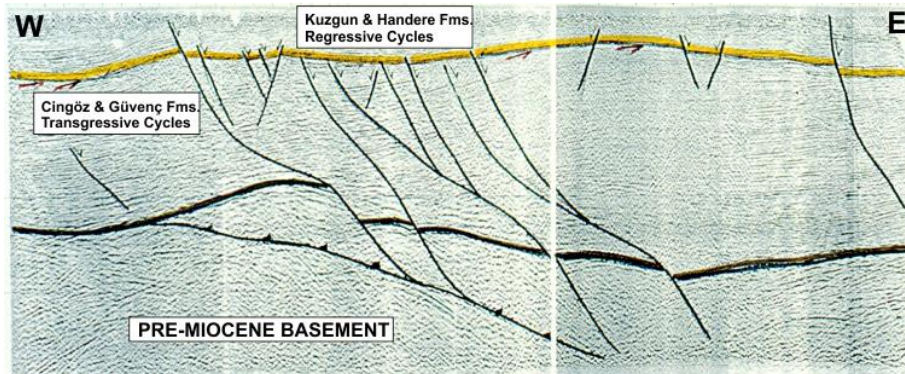


Figure 3. Interpreted W-E seismic profile showing stratigraphic relationships of Neogene units of Adana Basin

This unit is dominated by bluish gray-greenish gray, thin parallel bedded and convolute laminated carbonaceous shales, calcareous siltstones, marls, and very thin fine sandstones with abundant microfauna. The shale layers contain abundant pelagic and benthic foraminifera and some ostracoda. (ii) an offshore type cycle is best seen further south around Çakallı village north of Çatalan village. This unit is characterized by yellowish gray, medium and partly thick bedded,

relatively massive sandstones and siltstones with some shale intercalations. The sandstones are petrographically calcareous feldspathic arenites and appear similar in composition to the sandstones of the Cingöz Formation [5]. (iii) a shallow marine sediments unit is seen south of units (i) and (ii) around Çatalan village, north of Kuzgun and Mucurlu villages. This member dominantly comprising bluish shales and siltstones with some reworked sandstones (Figure 4).

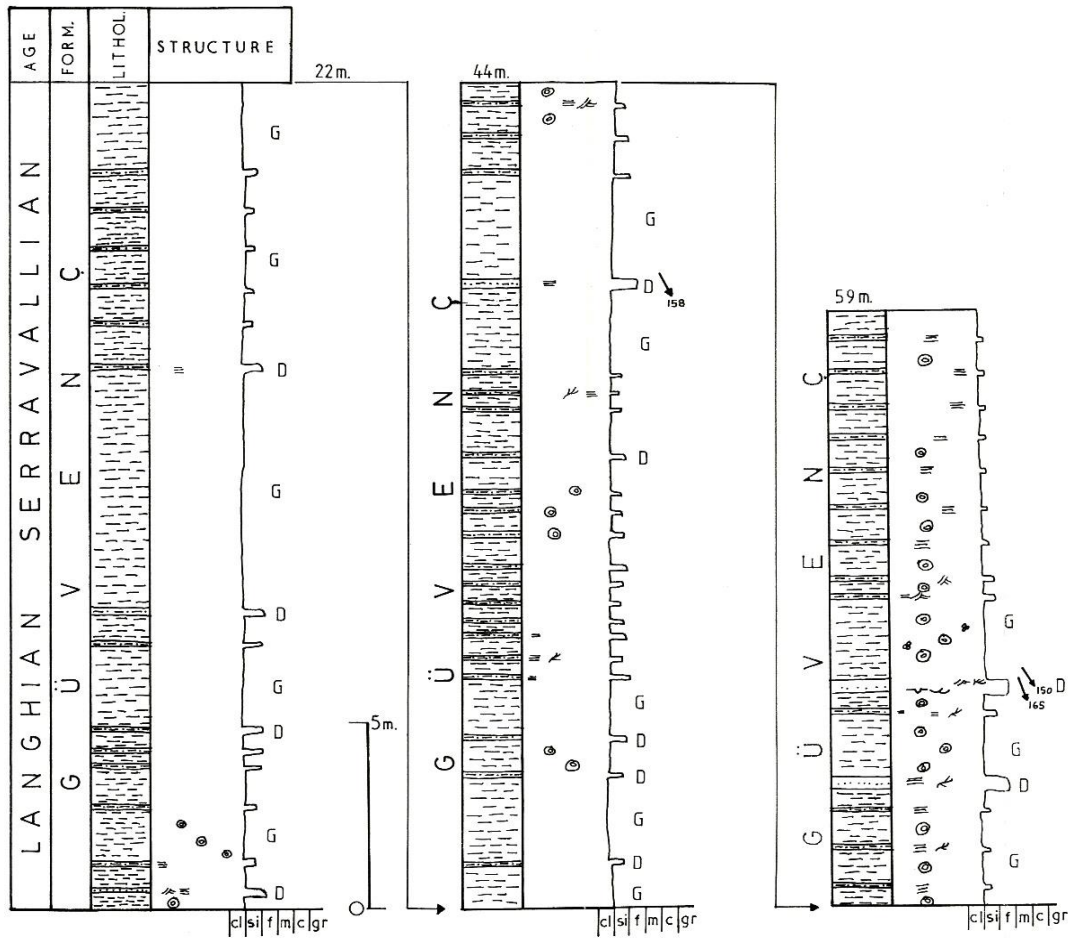


Figure 4. Sedimentological log through the middle part of the Güvenç Formation (measured on a roadcut nearly 1.5 km south of Güvenç village)

Also in the upper part of this member, close to the contact with the Kuzgun Formation, yellowish, medium to thick bedded sandstones interpreted as storm deposits [6], and some large burrows have

been observed. The shallow marine member of the Güvenç Formation is overlain by the major regressive sequence of the Adana Basin, the Kuzgun Formation above a low angle

unconformity. According to the benthic and planktonic foraminifera faunas recovered from the Güvenç Formation, a Langhian-Serravallian age is indicated, with deep marine environmental faunal characteristics, together with some possible shallow marine characteristics has been suggested for this unit by Nazik and Tokar [7].

3. KUZGUN FORMATION

The major regressive sequence of the Adana Basin is represented by the post Middle and Upper Miocene age sediments that constitute the Kuzgun and Handere Formations. Briefly, the Kuzgun Formation in the study area is divided into three members. The lower part of the formation which consists of channelized conglomerates, cross

bedded sandy conglomerates, sandstones and mudstones is named the Kuzgun Member, while the alternation of marls, sandy siltstones and tuffites which forms the middle part of the formation is named the Salbaş Tuff Member. The upper part, which mainly comprises conglomerates, sandstones, siltstones and shales is named the Memişli Member. The rock assemblages of the Kuzgun member show significant lateral differences on a basinal scale. However, the basal unit is usually represented by deeply eroded channels filled with gray-yellowish gray or brown, thick-very thick beds of cross bedded conglomeratic and sandy conglomeratic sediment, succeeded by yellowish-gray-beige, thick beds of moderately cemented, cross bedded, (laterally accreted) pebbly sandstones (Figure 5).

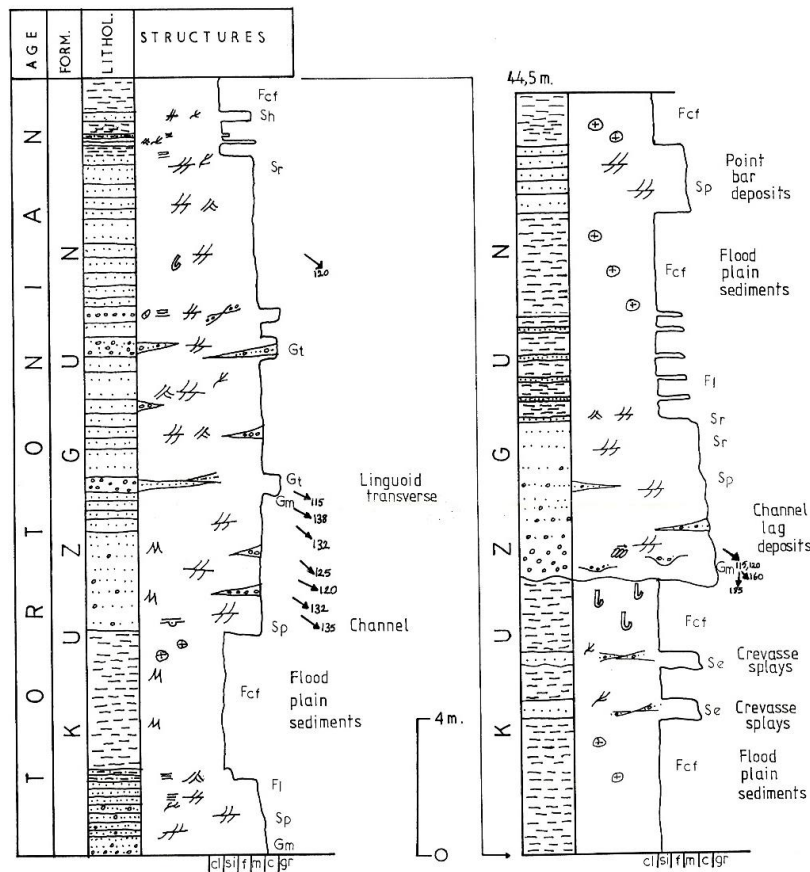


Figure 5. Sedimentological log of lower part of the Kuzgun Formation, measured on a roadcut-cliff approx. 4 km northwest of Kilbaş village

This unit displays characteristics of meandering river deposits and passes upwards into brownish mudstones and white-light gray, poorly cemented sandstone alternations (flood plain). The uppermost levels of this member are characterized by gray-dark gray, thick channelized, cross bedded, moderately well cemented, fine grained pebbly sandstones. In the fluvial deposits, a mammalian skull, teeth and bones were found at a locality Çatalan Dam excavation approximately 4 km south of Çatalan village. The gray fine grained pebbly sandstones is succeeded by gray, medium to thick bedded sandstones including some calcrete nodules. The uppermost part of the Kuzgun Member comprises yellow-brown, medium-thick bedded, hard sandstones with minor shale intercalations and includes a few silty sandstones rich in *Ostrea* shells (lagoonal-shallow marine environment). The Kuzgun Member succeeds the shales of the Güvenç Formation abruptly and with low-angle discordant contact seen around Kuzgun and Mucurlu villages.

The Memişli member of Kuzgun formation separated from Kuzgun member by earlier mentioned key level of Salbaş tuff member. The Memişli Member is mainly composed of conglomerates, sandstones and siltstones of probable terrestrial, shallow marine and fluvio-deltaic origin and displaying marked lateral facies changes. Therefore, the member shows somewhat different vertical successions at different localities. Notwithstanding, the lowermost part of the member starts with channelized conglomerates and is succeeded by pebbly conglomerates and fining upward cycles of sandstones and siltstones. This passes upwards into moderately consolidated siltstones, sandstones and mudstones of probable shallow marine and/or deltaic character. The succeeding part generally is represented by a thickening upward silty-sandy sequence including parallel and cross lamination, load casts and burrows. The uppermost levels are mainly represented by siltstone intercalated with shales including some marine fossils.

According to the molluscan faunas determined by Tanar [8], a broadly Tortonian age can be given to the Kuzgun Formation. The determined fossil

assemblages evidence actually shows that the age of this member could range between the middle and upper Miocene. This period also represents the timing of the last marine inundation in the basin.

4. CONCLUSIONS

The Cenozoic deposits in the Adana Basin may be assigned to pre-transgressive, transgressive and regressive sequences. The earliest Cenozoic formations, forming the pre-transgressive sequence, crop out in the N and NW part of the basin, and comprise the ?Upper Oligocene-early Miocene Gildirli Formation. The cycle associated with the last major transgression of the Miocene sea includes the Kaplankaya, Karaisalı, Cingöz and Güvenç Formations, deposited during Aquitanian and Serravallian times. The boundary between Güvenç and overlying Kuzgun Formation represents a transition from transgressional to regressional deposition which is documenting the ending of the last marine inundation in the region. Eventually, Tortonian age regressive sequences of the Kuzgun member of Kuzgun Formation comprising shallow marine (beach) sediments and meandering river deposits are resting on the Serravallian age transgressive Güvenç Formation with a low angle unconformity. In accordance with general shallowing of the Adana Basin during the Late Serravallian to Messinian interval, the deltaic and paralic Kuzgun and Handere Formations represent a major regressive cycle, leading to emergence of the western part of the basin by the late Tortonian.

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