Cenozoic Stratigraphy of the Güzelyurt Basin,
Turkish Republic of Northern Cyprus

HÜSEYİN GÖKÇEKUŞ* and ENGİN OLGUN**

ABSTRACT:

The Güzelyurt Basin is located in the western Mesoaloria Plain which consists of marine, foredeep deposits ranging in age at least from Oligocene to Pleistocene. The stratigraphical and depositional conditions of the Cenozoic rocks of the Güzelyurt Basin indicate a widespread subsidence, after the period of Troodos igneous activity. Thus, the stratigraphy of basin shows a continuous deposition during Cenozoic resting unconformably on the Troodos Massif.

At the Güzelyurt Basin, Pillow Lava Series of the Troodos Massif (Middle-Upper Cretaceous) are observed as the oldest rock units. Troodos Pillow Lava Series are overlain by the Cenozoic rock units of Lapithos Group (Oligocene-Lower Miocene), Dhall Group (Middle-Upper (? ) Miocene) and Mesoaloria Group (Upper Miocene-Upper Pliocene). These lithostratigraphical units are separated from each other by well-marked regional unconformities respectively; pre-Oligocene, pre-Middle Miocene and pre-Pliocene. Local stratigraphical breaks occur during Oligocene-Lower Miocene and Pliocene. The basin itself comprises fanglomerates (Pleistocene) and alluvial deposits (Holocene) of Quaternary rocks.

INTRODUCTION

Cyprus is roughly divided into three main geological units as the Kyrenia Range in the north, Troodos Range in the south and the Mesoaloria basin in between. The study area is located within the Güzelyurt basin at the northwestern part of Cyprus between the latitudes 35 04’48"N and 35 16’10"N and longitudes 32 47’30"E and 33 07’15"E (Figure 1).

A number of publications are available concerning the geology of Cyprus in general, as well as the Güzelyurt basin and its vicinity in particular. The first detailed geological investigation of Cyprus was carried out by Henson et al. (1949). Most of the presently accepted and widely used formation names were originally proposed by them. Other detailed geological
evaluations of Cyprus are given by Ingham (1955), UNDP (1970), Dregthorn (1978) and Keltin (1988). In addition to these, Wilson (1959), Moor (1960) and Gökçekuş (1990) are also directly related with the study area.

The purpose of this study is to establish the Cenozoic stratigraphy of the Güzelyurt basin. For this reason, 1/50,000 scale geologic map is prepared and the various Stratigraphic sections are measured in different localities to correlate and clarify the lithostratigraphical units.

STRATIGRAPHY

Troodos Pillow Lava Series

The pillow lava series of Troodos Massif are observed only in the southwestern part of the study area (Figure 2). It is divided into three groups as basal group, lower pillow lavas and upper pillow lavas (Ingham, 1955). Typically the pillow lavas are brownish-black color and fine to medium grained. They are extremely friable and easily weathered. The basal group constitutes the lowest part of the pillow lava series and comprises basic dykes of various composition. Some of the dykes and sills extend into lower pillow lavas of basaltic composition with small dark irregular masses and a considerable proportion of the lower pillow lavas is composed of intrusive dykes and sills. Therefore, the basal group and the lower pillow lavas probably represent a continuous volcanic episode in which the multiple dykes acted as feeders to the higher lava flows. Both the lavas and the intrusions have basic composition and basalt is the most common rock type. The vesicles of lower pillow lavas are frequently infilled with zeolite, chalcedony and quartz.

The lower pillow lava volcanic episode is fol-
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lowed by an interval of uplift and erosion. Then, the upper pillow lavas are extruded by overlying the lower pillow lavas. Therefore, the upper pillow lavas rest unconformably on the lower pillow lava series and are also, basaltic in composition. They may be distinguished from the lower pillow lavas by their light grey weathering pillows which are relatively free from intrusions. But, these differences between the upper and lower pillow lavas are not everywhere clearly defined.

It is impossible to estimate the thickness of the Troodos Pillow Lava Series on account of their very poorly defined flowing-planes. However, they attain a thickness of more than 1000 m in the study area.

The age of the Troodos Pillow Lava Series is uncertain. According to the previous investigators the Middle Cretaceous (Henson et al., 1949) and Late Cretaceous (Searly and Pana-yiotou, 1980) are assigned. The Troodos Pillow Lava Series have been dated by Delaloye et al. (1980) as 75 m.y. Based on isotopic age determinations, the age of the Troodos Pillow Lava Series has been suggested as 110–80 m.y., (Delaloye et al., 1980). Therefore, the age of the Troodos Pillow Lava Series is taken as Middle–Late Cretaceous in this study.

Lapithos Group

The group was first described and named by Gaudry (1862); in Henson et al. (1949). The Lapithos Group was later divided into three portions as Lower Lapithos (Late Cretaceous), Middle Lapithos (Eocene) and Upper Lapithos named as Ovgos Formation (Oligocene–Early Miocene) by Gass (1959) according to the palaeontological determinations.

In the study area only the upper portion of the Lapithos Group crops out and it is called as Ovgos Formation (Figure 2).

Figure 2: Geological map of the Güzelyurt Basin.
<table>
<thead>
<tr>
<th>Era/hem</th>
<th>Quaternary</th>
<th>N</th>
<th>Lower Pliocene</th>
<th>Lower Miocene</th>
<th>Upper Miocene</th>
<th>Middle–Upper Miocene</th>
<th>Oligocene</th>
<th>Lower Oligocene</th>
<th>Lower Cretaceous</th>
<th>Middle–Upper Cretaceous</th>
<th>Cretaceous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>Holocene</td>
<td>120</td>
<td>80</td>
<td>48</td>
<td>~45</td>
<td>100</td>
<td>60</td>
<td>450</td>
<td>795</td>
<td>105</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Formations</td>
<td>Alluviums, talus deposits, slope wash deposits, river terrace deposits, beach deposits and wind-blown sand deposits.</td>
<td>Fanglomerates, intercalated with sandstones and siltstones calcified at top. Conglomerates are composed essentially of poorly sorted, subangular to subrounded boulders, cobbles and gravels.</td>
<td>Well-bedded sandy marls, calcareous sandstones and conglomerates capped by limestones.</td>
<td>Yellow slightly pebbly, shelly limestones and subordinate gray, yellow and white marls with occasional conglomerate layers.</td>
<td>Marts are yellow, gray and less frequently white, generally homogeneous, but locally contain thin limestone bands; sandy layers are also present.</td>
<td>White and massive limestones which are partly recrystallized and appear to be reefal.</td>
<td>Thick sequence of limestones, red-brown and gray friable marl, calcareous sandstone, thin bedded chalks and shallow water gypsum lentils.</td>
<td>Alternations of greywacke, calcareous sandstone marl, foraminiferal limestone, calcarenites and bioclastic limestones; containing gypsum.</td>
<td>Friable white marls and pale gray recrystallized foraminiferal chalks. Marl and chalky layers are gradational.</td>
<td>Upper Pillow Lavas, Lower Pillow Lavas. Basal Group—comprises basic dykes of various composition.</td>
<td></td>
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Figure 3: Generalized stratigraphic column of the Güçelturk Basin (Compiled after Reed, 1930, Henson et al., 1949 and Ingham, 1955).
Ovgos Formation

It is well observed 3 km north of Serhatköy (Figure 2) and steeply dips to the north under the Kythrea Formation. The southern boundary of the Ovgos Formation has a tectonic contact with the younger formations, whereas it is separated from overlying Miocene units by an unconformity (Figure 3 and 4).

The formation is composed of friable white marls and pale grey chalks. The marly and chalky layers are gradational. The chalks are thin bedded, hard, richly foraminiferous but partially recrystallized. The total thickness of the formation is measured about 105 m in the study area (Figure 5).

The age of the formation was estimated as Oligocene by Henson et al. (1949), Miocene by Adams (1958), and Oligocene–Early Miocene by Gass (1959). The measured section in the north of Serhatköy yields Catapsydax sp., Globigerinoides trilobus, oides globigerina bisphericus, Globigerina quinquepartita, Globorotalia scitula, Textularia agglutinans, Vulvulina spinosa, Uvigerina spinocostata of the Oligocene–Early Miocene and Praerbulina glomerosa, Globigerinoides bisphericus of the Late...

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![Diagram of Cenozoic of Güzelyurt](image)

**Figure 4**: General view of the Ovgos Thrust and the formation involves (Along Leşkoşe – Güzelyurt Road). Tma: Athalassa fm., Tmm: Nicosia fm., Tmn: Myrtou Marl., Tdp: Pakhna fm., Tdky: Kythrea fm., Tlo: Ovgos fm.

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**Figure 5**: Measured columnar section of the Ovgos Formation (in the north of Gultekin Ridge).
Early Miocene. Also, the presence of the *Orbulina universa* indicates a Miocene age. In addition to these faunas, the chalks of Ovgos Formation contain some other benthic foraminifers such as *Cassidulina subglobosa* and *Siphonina reticulate* which are characteristic fossils of Early Miocene. So, the age of formation is Oligocene – Early Miocene.

**Dhali Group**

The Dhali Group was first named by Henson et al., (1949). The group is represented by Miocene shallow marine deposits unconformably overlie the Troodos Pillow Lava Series and Ovgos Formation. It is unconformably overlain by Mesozoria Group of Pliocene age (Figure 3). The group is divided into four formations, from bottom to top, the Terra Limestones, Kythrea Formation, Pakhna Formation, and Koronia Limestones (Henson et al., 1949). In the study area, the Dhali Group is represented by only the Kythrea Formation, Pakhna Formation, and Koronia Limestone.

The microfossil evidence and field relationships indicate that the Kythrea and Pakhna Formations are roughly contemporaneous but have entirely different facies. The age of Dhali group is determined as Middle Miocene by Dreghorn (1978) and Middle Late Miocene by Henson et al. (1949). The marls of the Kythrea and Pakhna Formations contain many species in common. In the measured sections, both planktic and benthic foraminifera are abundant. Some of the foraminiferal fauna include *Biorbulina bilobata*, *Mio gypsum* sp., *globigerina bulloidis*, *Orbulina sp.*, *Orbulina universa*, *Orbilinga suturalis*, *Globocadra* *na deliseus*, *Globocadra* *alltipara*, *Globigerinoides* *conglobatus*, *Globigerinoides* *trilobus*, *Cibicides* *italicus*, *Discorbis* *globularis* as Planktic species and *Amphistegina* *chippolensis*, *Asterigerina* *planorbis*, *Robulus* *rotulatus*, *Rotalia* *beccarii*, *Siphonina* *planocorvexa*, *Uvigerina rutil* as benthic species. Towards the top of this succession there is a hard chalk band containing *Discosipirina* *italic*. Indicating a Late Miocene age. Therefore, the age of Dhali group is estimated as Middle-Late (?) Miocene.

**Kythrea Formation**

The formation is extensively well exposed at the northeastern part of the study area (Figure 2). It consists of alternations of sandstones, marls, foraminiferal limestones, and bioclastic limestones. Occasionally, thin gypsum interbeds are also noted within sandstone and marl alternations (Figure 6). Sandstones are mostly made up of angular and unsorted frag-
ments of quartz, feldspar and various rock fragments embedded well cemented within an argillaceous matrix.

Marls generally grade into shales and marly limestones. Foraminiferal limestones are mainly composed of foraminifera fragments with lesser amount of arenaceous material. Calcarenites are not very commonly observed. They consist of poorly consolidated and poorly sorted sand particles with some chalk material in a fine grained calcitic cement. Bioclastic limestones consist of very fine, rounded grains of crystalline limestone fragments also containing unrecognizable preserved fossils.

The Kythrea formation unconformably overlies the Ovgos formation of Oligocene–Early Miocene age. This unconformable relationship is well observed. 3.5 km north of Serhatköy. At the same locality, it is overlain conformably by the Pakhna Formation. Along the Lefkoçe–Güzelyurt road, Kythrea Formation is overlain unconformably by the younger Athalassa Formation (Figure 7).

The thickness of the formation is measured as 795 m in the east of Kalkanlı village.

**Pakhna Formation**

The Pakhna Formation is well observed 2 km northeast of Serhatköy and 3 km northeast of Kalkanlı in the eastern part, and north of Beyaz Hill in the western part of the study area (Figure 2).

It mainly consists of a thick sequence of limestones, red-brown and grey friable marls, calcareous sandstones, thin bedded chalks, and shallow water gypsum lenses. The Pakhna Formation is the lateral equivalent of the Kythrea Formation. The boundaries between Pakhna and Kythrea is unfortunately obscured by younger deposits. The formation unconformably overlain by the Myrtou Marl in the west and the Nicosia Formation and Athalassa Formation in the east. Locally the Quaternary deposits also overlie the formation unconformably.

The maximum thickness of the formation is about 450 m. In the study area the Pakhna Formation shows similar fossils with those of the Kythrea Formation. The foraminifers determined only from the Pakhna marls are: *Cibicides lobatulus*, *Cibicides boueana*, *Globigerinoides rubra*, *Globigerina quadrirpartita*, *Miogypsina* sp., *Nodosaria proxima*, *Heterostegina* sp., *Cassidulina subglobosa*. Thus its age is determined as Middle–Late (?) Miocene.

**Koronia Limestone**

The Koronia Limestone is well observed around Bağlıköy, 2 km southwest of Taşköy and around Lefke (Figure 2). The Koronia Limestone is underlain by the Troodos Pillow Lava Series and in some localities by the Myrtou Marls and gypsum lenses of the Pakhna Formation. The boundary relationships between the Koronia Limestones and below Troodos Pillow Lavas, and above Myrtou Marls are an unconformity in the western part of the study area (Figure 8). They are composed of white and massive reeval recrystallized limestones. The maximum thickness of the limestone is 60 m. The age of the Koronia

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**Figure 7** : General view of the Kythrea Formation capped by Athalassa Formation (Along Lefkoçe-Güzelyurt road). Tma: Athalassa fm, Tdky: Kythrea fm.

**Figure 8** : The boundary relationships between the Troodos Pillow Lava Series (TPLS) and Koronia Limestone (Tdko) (in the vicinity of Bağlıköy).
Limestone is also determined as Middle–Late (?) Miocene because it passes laterally into Pakhna Formation and the lithological and palaeontological similarities with underlying formations. In the vicinity of Lefke, the following fossils of Lamellibranchia such as, Amussium sp., Cardium multicostatum, Lucina fragilis, Miocardia mollichanoiides and Gastropoda such as, Favia sp. are determined indicating Middle–Late (?) Miocene age.

**Mesaoria Group**

The Group was first introduced and divided into five formations as Myrtou, Pisiuri, Nicosia, Kyrenia, and Athalassa by Henson et al., (1949). The rocks comprising this group are the different facies of the same transgression. The Pisiuri and Kyrenia Formations are not observed in the study area and the Mesaoria Group is represented by the Myrtou Marl, Nicosia Formation and Athalassa Formation (Figure 3 and 9). The age of the group is suggested as the Late Miocene–Pliocene. Macrofossils such as, pectens and other bivalves are found at certain horizons in the marls of the Myrtou and Nicosia Formations. Also, in the limestone beds of Nicosia Formation, the shells of Pecten, Cardium and Gastropods are observed.

**Myrtou Marl**

Generally, the formation is well exposed around Meveli village in the east and in the vicinity of Çamlıköy, Taşköy, Madenli, and Bağlıköy in the west (Figure 2). They rest unconformably (around Beyaz Hill) in the west (Figure 3) and pass transitionally into the upper Nicosia Formation in the eastern part of the study area (Figure 10). But, the Nicosia Formation is frequently overstepped and the Myrtou Marls are overlain by Athalassa Formation, Fanglomerates and Quaternary deposits.

The Myrtou Marls are yellow gray and less frequently white. They are generally homogeneous but locally contain thin limestone layers. Locally, brown or buff color sandy layers are present. The Myrtou Marls near to the transition to Nicosia Formation, are characteristically more yellow and contain thin beds of more shelly, harder and sandy marls which typically contains casts of molluscs. The thickness of the Myrtou Marl is measured as about 100 m and its age is determined as Late Miocene–Early Pliocene. The Marls contain large fauna of numerous planktic foraminifers taxa as Globigerinoides trilobus, Globigerinoides conglobatus, Globoguadrina attipiria, Orbulina universa, Globorotalia bulloidis, Globorotalia cf. crassula and benthic species of Bulimina sp., Bulimina elongata, Bulimina ovata, Asterigerina planorbis, Cibicides oblongus, Cibicides lobatulus, Elphidium crispum, Vaginulina tricarinata, Nodosaria radiatula, Nodosaria acuminata, Nodosaria adolphina indicating a Late Miocene–Early Pliocene age.

**Nicosia Formation**

The Nicosia Formation has small outcrops in the study area. It is well observed approximately 1 km north of Serhatköy and around Meveli village (Figure 2). The formation lies conformably on Myrtou Marl and unconformably overlain by the transgressive Athalassa Formation (Figure 9 and 10). The formation is characterized by yellow shelly limestones, and grey, yellow and white marls together with conglomerates. The thickness of the formation is about 45 m in the study area, however, it is over 600 m in the center of the depositional basin near Lefkoşe (Henson et al., 1949).

The limestones of Nicosia Formation contain Miliolids, Rotaliids, Globigerinids, Molluscs, and Brachiopods. It was not possible to determine any index fossil. According to the macrofossil determinations an Early–Middle Pliocene age was given by Reed (1935).
Figure 10: Measured columnar section of Mesaoria Group indicating Myrtou Marl (Tmm), Nicosia Formation (Tmn) and Athalassa Formation (Tma) (in the vicinity of Gültekin Ridge).
Athalassa Formation

The formation is largely exposed in the eastern part of the study area and also, near the shoreline as isolated flat-topped hills. The Athalassa formation is characterized as a transgressive unit which rests unconformably on all the older rocks, more commonly on the Kythrea Formation and less commonly on Myrtou Marl and Nicosia Formation (Figure 7 and 9). The Formation is mostly covered by the Quaternary deposits.

The Athalassa Formation consist of well-bedded sandy limestone, calcareous sandstone, and conglomerate overlain by limestone (Figure 10). Moore (1960) has divided this formation into two members as the marl and conglomerate member at the bottom and bioclastic limestone member at the top. The conglomerates of the Athalassa Formation are generally poorly-cemented, well-sorted and the pebbles are rounded. They are generally shaly and contain sandy and calcareous matrix. The marls are gray and less commonly yellow, calcareous, and rich in foraminifers. The bioclastic limestones are pale to yellow, massif, sandy, medium grained, slightly glauconitic and iron stained. Essentially the limestones consist of rounded fragments of fossils, which are coated by calcareous sheets with the very little fine grained matrix. Toward west the limestones are more sandy, thinly laminated, friable and in many places pass into calcareous shaly sandstones in the cliffs along the Güzelyurt Bay.

The conglomerates occur at the base of marls and bioclastic limestones are not well-developed and grade laterally into marls near Serhatköy, Mevlevi and Kalkanli villages. In the study area, south of Serhatköy, the thickness of the formation is about 48 m and in the vicinity of Gültekin Ridge is 36 m. In the Athalassa Formation, some benthic genera such as Amphistegina and Rotalia are determined. The marls of the Athalassa formation contain Pliocene foraminifers such as, Elphidium crispum, Rotalia beccari, Globigerina bulloides, Globigerinoides elongatus, Globigerinoides trilobus, Orbulina satunai, Biorbilia bilobata, Globoratila cf. scitula, Nodosaria sp., Virgulina complanata of the Late Pliocene age.

Quaternary Deposits

The Quaternary deposits comprise Pleistocene Fanglomerates and Holocene deposits (Figure 3).

Fanglomerates

In the study area, the fanglomerates are well exposed at the south of Güzelyurt and in the vicinity of Doğancı and Cengizköy. They form gently dipping topographic slopes bordering the Güzelyurt basin in the south and southwest.

They consist of conglomerates intercalated with sandstones and siltstones. The conglomerates are essentially composed of poorly-cemented and poorly-sorted, subangular to subrounded boulders, cobbles, and gravels which fan out from the Troodos Range towards north. The diameter of individual pebbles may be as large as 60 to 70 cm.

The components of the fanglomerates are derived from the Troodos Range and younger rock of Tertiary age. Towards top, well-developed caliche layers up to 5 m thick are observed. This is typical for semi-arid to arid climates.

The maximum thickness of the fanglomerate is measured as 80 m around Kilise Hill and they gradually thin out towards north. The age of the fanglomerates is estimated as Pleistocene by Moore (1960).

Holocene Deposits

The Holocene deposits comprise alluviums, talus deposits, slopewash deposits, river terrace deposits, beach deposits, and wind-blown sand deposits. They are, however, undifferentiated on the geological map (Figure 2).

The Holocene deposits consist of gravels, sands, silts and clays in various proportions. They constitute the major valley fill of the Güzelyurt plain. The maximum thickness of these deposits is about 120 m.

DISCUSSION AND CONCLUSION

Three major cycles of sedimentation are represented in the exposed rocks of Güzelyurt Basin; the Oligocene–Lower Miocene (Lapiithos Group), Middle–Upper (?) Miocene (Dhali
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Group) and Pliocene (Mesaoria Group). Towards the center of basin, there is a transition from shallow marine to the deep marine conditions which are later effected by major transgressions and regressions related to progressive uplifting of Troodos Massif and rapid subsidence. Therefore, lateral and vertical facies changes are developed well especially in the Miocene and Pliocene rock units.

No definite boundaries are detected between the pillow lava series of Troodos Massif which are apparently transitional. But, in some localities the different intrusive material components of pillow lava series yield the existence of unconformities between them.

The stratigraphy and depositional conditions of the Cenozoic rocks of the Güzelyurt Basin indicate a widespread subsidence, after the period of Troodos Igneous activity. Then, there is a period of sedimentation starting in the Upper Cretaceous and continuing into the Lower Miocene with the chaks of the Lapithos Group being deposited, probably over the whole area. The sea apparently transgressed across a shoreline of low relief. But, the deposition is interrupted by epirogenic movements in the Güzelyurt Basin and a noticable stratigraphical break is occurred between Upper Cretaceous and Oligocene. During this subsidence, the Ovgos formation was formed in the NE part of the basin where chalk deposition continued from Oligocene to Lower Miocene.

At the end of the Lower Miocene, there is a further uplift and erosion of Troodos Massif in the Güzelyurt Basin and rapid erosion provided material for the Kythrea Formation. Therefore, the Early–Middle Miocene time is indicated by the precence of an unconformity between the older rocks and the Kythrea Formation. Throughout the Middle Miocene, there is a marine transgression and the deposition of Pakhna Formation as the lateral equivalent of the Kythrea Formation. Therefore, these formations are roughly contemporaneous. Then, the shallow water conditions resulted in the deposition of the reeal Koronia Limestone which is a marginal reef of the transgressive Middle–Late (?) Miocene. The Koronia Limestones are a littoral facies of the Pakhna Formation. So, they are observed as can passing laterally into Pakhna chalks. During the Upper Miocene whole area is again uplifted and intensely faulted.

Towards to end of the Upper Miocene, further submerge of the basin takes place and globigerinal marls are deposited to the floor of Güzelyurt Basin as Myrtou Maris alternating with contemporaneous flat–lying sediments of the Nicosia Formation. The Myrtou Marls represent the initial deposition in lower parts of the Güzelyurt Basin at the beginning of the Pliocene submergence. Therefore, the fossiliferous, shallow water, current–bedded rocks of the Nicosia Formation is deposited in the littoral zone along the margins of uplifts. Then the Athalassa sea is transgressed over the Nicosia formation forming an unconformity. The pebbles along the line of contact in the Athalassa Formation indicate intertidal emergence. After the deposition of the Athalassa Formation, the Pleistocene fanglomerate series and Holocene deposits are derived from rising Troodos Massif due to the post–Pliocene uplift.

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