

GEOLOGY OF THE ÇAMARDI (NİĞDE-TURKEY) REGION

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ABSTRACT: *The Çamardı region lies in the southern part of the Central Anatolia 68 km southeast of Niğde. The rock units of the Çamardı region are, Paleozoic-Mesozoic Niğde Group, Cenomanian Üçkapılı Granodiorite, Late Cretaceous-Paleocene Çamardı Formation and Early-Middle Eocene Evliyatepe Formation. The rock units of the Ulukışla Basin are represented with the Late Cretaceous-Late Paleocene Eskiburç Group in the study area.*

Niğde Group consists of (1) the Gümüşler Formation composed of sillimanite-biotite-muscovite gneisses with lenses of white marbles and calc-silicate marbles, and (2) the Aşıgediği Formation, characterized by thick bedded marbles intercalated with amphibolites and followed upward by cherty marbles. The Aşıgediği Formation overlies the Gümüşler Formation with a pre-metamorphism unconformity. The Üçkapılı Granodiorite intrudes the Niğde Group and crops out as patches crossed by pegmatite dykes. Çamardı Formation consists of conglomerates and sandstones derived mainly from the Niğde Group. The Evliyatepe Formation unconformably overlies the Çamardı Formation and includes conglomerates and alternations of sandstones, siltstones and silty limestones.

The Eskiburç Group which represents the oldest deposition of the Ulukışla Basin consists of (1) Ovacık Formation characterized by flysch-like sequences and chaotic mixture of volcanic and volcano-sedimentary rocks, and (2) Ulukışla Formation with volcano-sedimentary and volcanic rocks.

The most significant Neotectonic features in the study area are the Üçkapılı Normal Fault and the Celaller Thrust along which the rock units of the Niğde Region are thrust over the Eskiburç Group.

ÇAMARDI BÖLGESİNİN JEOLojİSİ (NiğDE - TURKİYE)

ÖZ: Çamardı bölgesi Orta Anadolu'da Niğde'nin 68 km güneydoğusunda yer almaktadır. Çamardı bölgesinin kaya birimleri, Paleozoyik-Mezozoyik Niğde Grubu, Senomanian Üçkapılı Granodiyoriti, Geç Kretase-Paleosen Çamardı Formasyonu ve Erken-Orta Eosen Evliyatepe Formasyonudur. Ulukışla Baseni kaya birimleri çalışma alanında Geç Kretase-Geç Paleosen Eskiburç Grubu ile temsil edilir.

Niğde Grubu, (1) beyaz mermer ve kalk-silikat mermer mercekli silimanit-biyotit-muskovit gnayslarından oluşan Gümüşler Formasyonu, (2) amfibolit ara katkılı, üste doğru çörtlü mermerlere geçen kalın tabakalı mermerle karakterize edilen Aşıgediği Formasyonundan oluşur. Aşıgediği Formasyonu, Gümüşler Formasyonunu metamorfizma öncesi bir uyumsuzlukla üzerler. Niğde Grubu'nu kesen Üçkapılı Granodiorit sokulumu pegmatit daykları tarafından kesilmiş küçük mostrolar halinde gözlenir. Niğde Grubunu uyumsuzlukla örten Çamardı Formasyonunun çakıldaşları ve kumtaşları tamamen Niğde Grubundan türemiştir. Çakıldaş, kumtaş, silttaşı ve siltli kireçtaşı ar dalanmasından oluşan Evliyatepe Formasyonu tabanda Çamardı Formasyonunu uyumsuz olarak örter.

Ulukışla Basenindeki en genç çökelmeyi gösteren Eskiburç Grubu, volkanik ve volkano sedimentar kayaçların kaotik karışığı ile fliş benzeri birimlerle karakterize edilen Ovacık Formasyonu, ve volkanik ve volkano sedimanter kayaçlarından oluşan Ulukışla Formasyonlarından meydana gelir.

Orta Anadolu Kompleksinin Neotektonik öğeleri olan yapılar, NW-SE doğrultusunda Gümüşler ve Aşıgediği formasyonlarını kesen Üçkapılı Normal Fayı ve uzanımı boyunca Niğde Grubu kayaçlarının, Eskiburç Grubu üzerini itilmelerini sağlayan Celaller Bindirmesidir.

1. INTRODUCTION

The Çamardı region lies in the southeastern part of the Central Anatolia, within Niğde province. Çamardı is 68 kms southeast of Niğde along the Niğde-Pozantı (Adana) highway. In the Çamardı region, the geological studies so far carried out do not clearly establish the contact relationships between Niğde Group, one of the major components of the central Anatolian Complex, and the Eskiburç Group from the Ulukışla Basin. The aims of this study are to determine the distinctive features of the Çamardı region, and the relationships between the Niğde Unit (Niğde Group and the cover) and the rock units of Ulukışla Basin.

2. REGIONAL GEOLOGIC SETTING

The Çamardı region lies at the southernmost part of the Central Anatolian Massif which includes the Kırşehir Massif, Niğde Massif and the Central Anatolian volcanics (Ketin,

1966). The study area covers the southeastern part of the Niğde Massif along its boundary with the units of the Ulukışla Basin. The area is surrounded by the Central Anatolian Volcanic and volcanoclastic rocks on the west and north, by the Ecemiş strike-slip fault zone and the Aladağ Unit of the Eastern Taurides on the east and by the volcanics and volcano-sedimentary sequences of the Ulukışla Basin on the south (Figure 1).

The Niğde Massif is the assemblage of metamorphic rocks of various types intruded by granodiorite (Blumenthal, 1941; Kleyn, 1968; Göncüoğlu, 1977; 1980). The metamorphic rocks include Niğde Group (Göncüoğlu, 1977) and meta-ophiolite. The Niğde Group consists of three formations, from oldest to youngest, Gümüşler, Kaleboynu and Aşıgediği formations (Göncüoğlu, 1977; 1980). The meta-ophiolite is composed of meta-gabbros, meta-ultramafics and metamorphic equivalents of graywackes (Göncüoğlu, 1977; 1981; 1988). The Üçkapılı Granodiorite intruding the metamorphic rocks of the Niğde Group, includes stocks as well as aplitic and

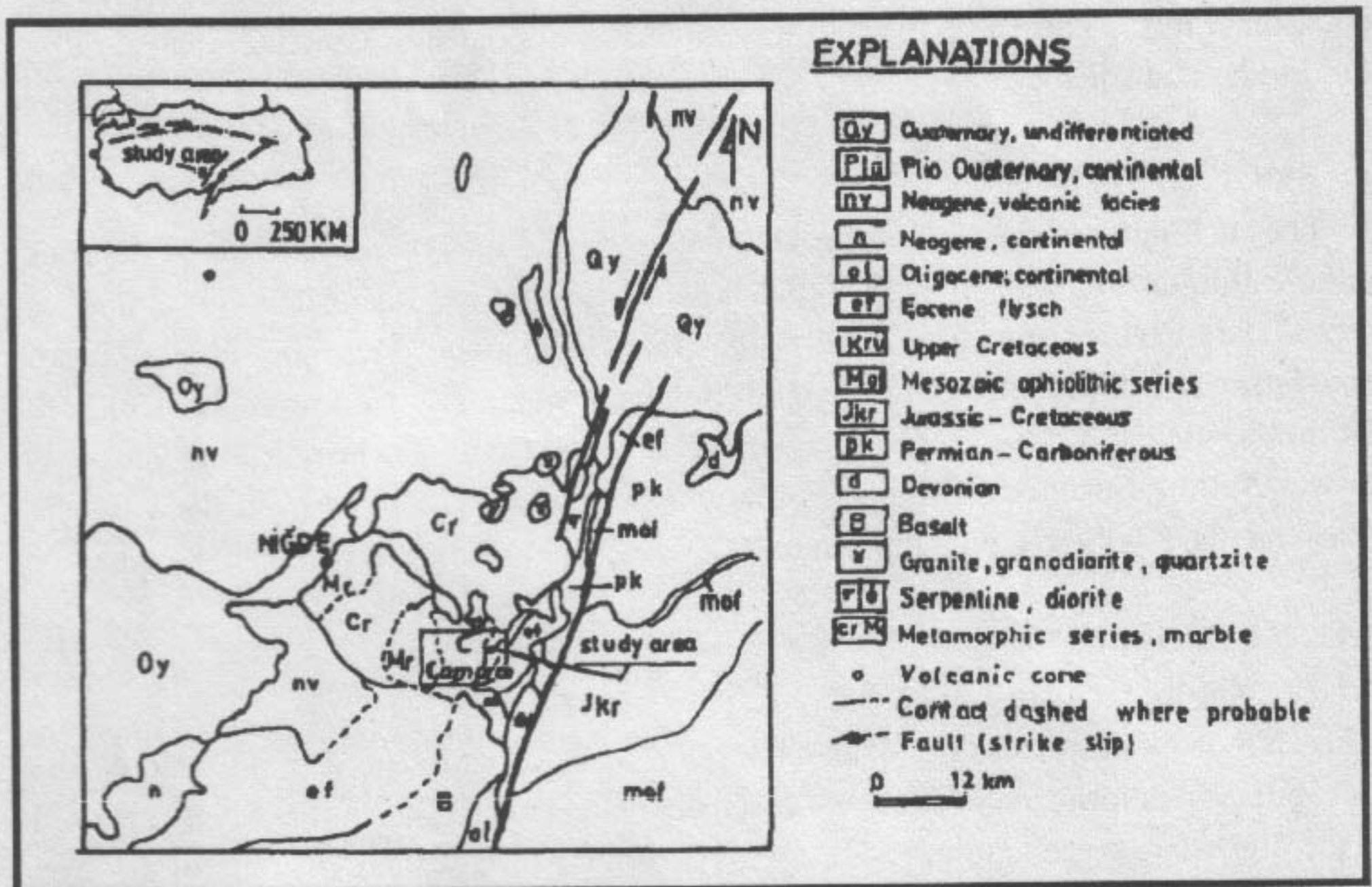


Figure 1. Regional geologic map of the Çamardı region (simplified from Ketin, 1963).

pegmatitic dykes (Göncüoğlu, 1977). The deposition, metamorphism and deformation of the Niğde Group ended prior to Maastrichtian indicated by the oldest non-metamorphosed Elmadere Olistostrome (Göncüoğlu and others, 1991). associated

with the Niğde Massif that contains microfossils of Maastrichtian age (Göncüoğlu, 1985), around the Elmadere to the NW of the Çamardı region.

The Ulukışla basin is characterized by the presence of island-arc volcanics related carbonates and flysch-like sequences derived from these rocks (Oktay, 1982). The rock units are classified into three groups as (1) the Ulukışla Group (2) the Kılan Group (3) the Bohçadikmen Group (Oktay, 1982). The basin persisted during Late Cretaceous to Late Paleocene extending to Lower Eocene (Oktay, 1982; Dellaloğlu and Aksu, 1986).

The pyroclastics and the volcanic rocks of Pliocene to Quaternary age derived from the volcanic activities of the Hasandağı, Melendizdağı and the Erciyes are the younger volcanic rocks to the west and north of the Niğde Massif. Lower parts of the volcanoclastic sequences are mostly ignimbritic (Beekman, 1966) intercalated with ash-flows, tuffite and tuffs (Atabey and Ayhan, 1986). The upper parts of the unit consists of basalt and andesites characterized by several flow units.

The fluvio-lacustrine clastic rocks of Neogene age consist of Çukurbağ Formation Oligocene-Miocene in age and Burç Formation miocene-Pliocene in age (Yetiş, 1987). Among these, the Çukurbağ Formation is characterized by red thick bedded river type conglomerates. The Burç Formation contains coal bearing lacustrine shales, silty, limestones and siltstones.

3. ROCK UNITS

The rock units of the Çamardı region are classified into two subgroups as (1) rock units within the Niğde Unit and (2) rock units of the Ulukışla Basin. The first group of rocks are divided into four subdivisions as (1) Paleozoic-Mesozoic Niğde Group consisting of Gümüşler and Aşıgediği formations, (2) Cenomanian Üçkapılı Granodiorite, (3) Upper Cretaceous-Paleocene Çamardı Formation, and (4) Lower-Middle Eocene Evliyatepe Formation (Figure 2). The units from the Ulukışla Basin are the Eskiburç Group that contains Ovacık and Ulukışla formations.

3.1 Niğde Unit

3.1.1 Niğde Group

The Niğde Group consisting of metamorphic rocks of various types, intruded by the Üçkapılı Granodiorite named initially by Göncüoğlu (1977). This unit is widely exposed at the northeast, north and north-northwest occupying almost three quarters of the area (Figure 2). In the Çamardı region, Niğde Group is represented by the Gümüşler and Aşıgediği formations. The lower contact of the group is not exposed within the area. It is nonconformably overlain by the Upper Cretaceous-Paleocene Çamardı Formation in the southern and southeastern part around Çamardı, Celaller and Kavaklıgöl (Göncüoğlu and others, 1991). The Niğde Units (Niğde Group, Çamardı and Evliyatepe formations) is thrust southwards over the units of the Ulukışla Basin

(Eskiburç Group) at the south of Ortatepe and southeast of Evliya and Kışlabayır Tepe along the Celaller Thrust Fault (Kuşcu, 1992).

3.1.1.1 Gümüşler Formation

The gneisses with marble lenses and quartzites which are the metamorphic equivalents of fine grained clastics and carbonates are named as the Gümüşler Formation by Göncüoğlu (1977). It is mostly exposed along a wide belt from the northwest of Celaller to the northeast of Çamardı (Figure 2). The Gümüşler Formation is usually overlain by the Kaleboynu Formation within the Niğde Massif. However, the Kaleboynu Formation, is not observed within the study area. Depositional characteristics of the protoliths change from a sequence of fine grained clastic rocks and volcano clastic rocks to platform carbonate rock at the upper part. Aşıgediği Formation starts with reddish meta-clastic rocks (red quartzites) that suggest an old erosional surface and thus an erosional contact relationship between the Gümüşler and Aşıgediği formations. It is a pre-metamorphic unconformity and is verified mainly by discontinuity in lithologic characteristics of the metamorphic units.

The Gümüşler Formation consists of gneisses, marbles, calc-silicate marbles and quartzites. The gneisses are composed mainly of biotite, muscovite, feldspars, quartz, and sillimanite with sphene, tourmaline, apatite and chlorite as accessories. Alteration of feldspars to clay minerals and biotites to chlorites are common. Gneisses appear to be cataclastically deformed due to post metamorphic deformation. The quartz lenses of various sizes and shapes within the gneisses form well developed augens.

The white marbles are observed as lenses within the gneisses. They are composed mainly of calcite with minor amounts of quartz and trace amounts of muscovite and opaque minerals. Cataclastic deformation is well observed on the calcite crystals. The calc-silicate marbles are characterized by white bands of granoblastic calcite with alternations of yellow to gray bands consisting of diopside, biotite, plagioclase, epidote and quartz. They also contain scapolite and sphene (Göncüoğlu, 1988; Kuşcu 1992).

The quartzites occur as bands with tens of metres in thickness and several kilometers in length. Macroscopically, they show probable primary sedimentary structures such as lamination and cross-bedding. They consist of granoblastic quartz and muscovite. Additionally, presence of altered feldspar and tourmaline is reported (Göncüoğlu, 1988).

The study of zircons enriched from the para-gneisses by U/Pb method indicates that the para-gneisses contain clastics from a Proterozoic aged (2059 ± 77 my) source terrain (Göncüoğlu, 1986). A lower Paleozoic age has been assigned to the Gümüşler Formation due to correlation with the low grade metamorphic Yahyalı Unit (Göncüoğlu and others, 1991). The Gümüşler Formation is correlated to Maden and Çamardı formations of the Pozantıdağı Massif (Viljoen and İleri, 1973), and to the Lower Series of the Niğde Crystalline Complex (Kleyn, 1970).

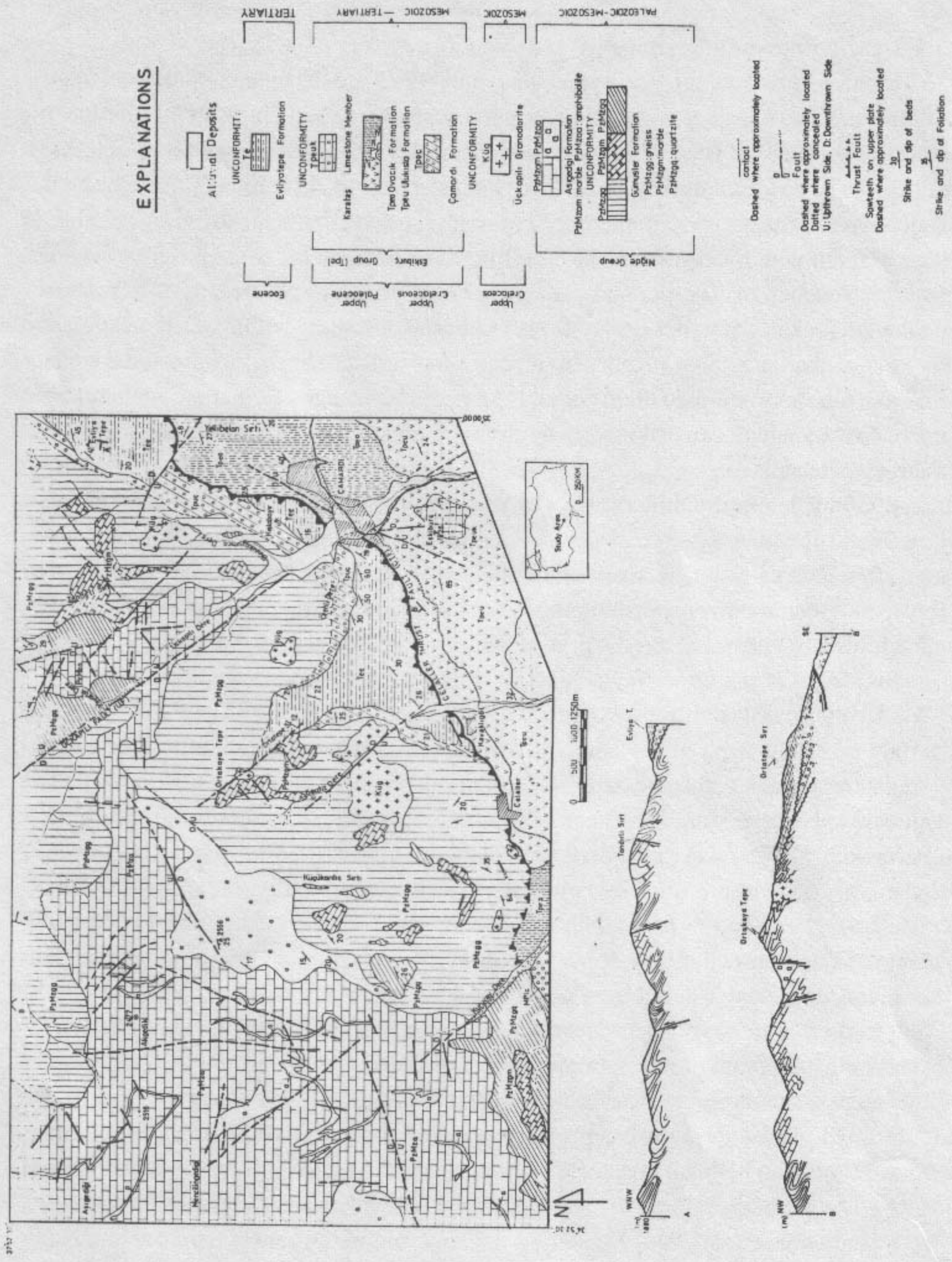


Figure 2. Geological map of the Çamardı region (after Kuşcu, 1992).

3.1.1.2 Aşıgediği Formation

The Aşıgediği Formation is named by Göncüoğlu (1977). It is dominantly exposed at the Aşıgediği, Mencilingediği, and Akgedik to the northwest of the region (Figure 2).

The Aşıgediği Formation is composed of massive, coarse grained thick, white-beige marbles with amphibolite interlayers and cherty marbles. The amphibolite interlayers are the characteristic features acting as marker horizons to map the formation and to understand the folding pattern of the metamorphics. The cherty marbles constitute the upper levels of the formation representing the metamorphic equivalents of the pinkish pelagic carbonates that passes upward to micritic limestone-chert alternation (Kuşcu, 1992). The amphibolites which may probably be derived from the metamorphism of tuffs, basic volcanics and marly units occur associated with the cherty marble and pinkish marble alternations. They are exposed as continuous bands within the marbles.

The age of the Aşıgediği Formation is Pre-Cenomanian, since it is intruded by the Cenomanian Üçkapılı Granodiorite (Göncüoğlu, 1986). The age of metamorphism is pre Upper Maastrichtian, since the non-metamorphic Elmadere olistostrome of Upper Maastrichtian age unconformably overlies the Aşıgediği Formation (Göncüoğlu and others, 1991). The Aşıgediği Formation can be correlated to the Middle Marble Series of the Niğde Crystalline Complex (Kleyn, 1970) and to the Kılavuz Formation of the Pozantıdağı Massif (Viljoen and İleri, 1973). A Middle Triassic-Lower Cretaceous depositional age had been assigned to this unit by regional correlations with the low metamorphic carbonates of the Kütahya-Bolkardağı Belt (Göncüoğlu, 1988).

3.1.2 Üçkapılı Granodiorite

The granodioritic intrusions in Niğde Massif with aplitic and pegmatitic dykes are named as the Üçkapılı Granodiorite by Göncüoğlu (1977). The Üçkapılı Granodiorite crops out at the north and northwest of Çamardı forming a series of small, isolated patches.

The Üçkapılı Granodiorite intruded into the Gümüşler and Aşıgediği formations. The contact of the granodiorite with metamorphic rocks, is characterized by a narrow zone of contact metamorphism and extensive weathering to limonitic and hematitic zones. The outcrops are associated with little amounts of aplites and pegmatites. The granodiorite is grayish to dark gray in color and medium to coarse grained. It is made up of quartz, muscovite, biotite, plagioclase, orthoclase \pm zircon \pm chlorite.

The field and microscopic features of the Üçkapılı Granodiorite in the region are different from those exposed at the type locality. Outcrops in the vicinity of faults are intensively sheared. Microscopical studies showed that (1) plagioclases and orthoclases are altered to sericites and only relicts are present, (2) quartz shows strong undulose extinction, (3) white micas seem to be aligned in micro-shear zones and some of them are bent, and (4) in some sections the rock shows blastomylonitic textures. These data

indicates that the Üçkapılı Granodiorite within the Çamardı region was cataclastically deformed. This deformation is probably due to (1) normal faults that either cross or closely located to the Üçkapılı Granodiorite, and (2) Celaller Thrust Fault that transported the block containing the granodiorite towards south. The age of this deformation should be post-Cenomanian (formation of the granodiorite) but pre-Miocene (upper limit of thrusting of the Niğde unit rocks to the Ulukışla Basin rocks).

The crystallization age of the granodiorite obtained by whole rock Rb/Sr isochrone as 95 ± 11 my corresponds to Cenomanian (Göncüoğlu, 1986). The Late Maastrichtian age of the non-metamorphic Elmadere Olistostrome containing fragments of the Niğde Group and the Üçkapılı Granodiorite (Göncüoğlu and others, 1991) also indicates to a pre-Late Maastrichtian intrusion age.

3.1.3 Çamardı Formation

The conglomerates and sandstones composed mainly of clastic fragments derived from the rocks of underlying Niğde Group, Üçkapılı Granodiorite and meta-ophiolite, are named as the Çamardı Formation (Kuşcu, 1992). The formation is restricted to a narrow zone trending in SW-NE direction from the west of Kavaklıgöl towards the north of Evliyatepe. It nonconformably overlies the Niğde Group and the Üçkapılı Granodiorite and unconformably overlain by the Evliyatepe Formation at Evliyatepe and to the northwest of Kışlabayır Tepe.

The conglomerate is polygenic and composed of sub-angular to angular fragments of marble, quartzite, gneiss and granite ranging in size from sand to boulder or even larger. They are supported by a fine grained, sandy to silty matrix derived from the gneisses of the Niğde Group. Slaty cleavage and small scale folds are observed within the matrix of the conglomerates. The general appearance of conglomerates with their matrix, is similar to a deformed metamorphic unit, since all the particles and the matrix that support them are directly derived from the underlying metamorphic rocks (Kuşcu, 1992).

The sandstones are grayish to dark gray in color. Marble and quartzite fragments are dominant components of the sandstones. The gneiss and granodiorite particles are little in amount, some benthonic fossils such as Nummulites sp., Discocyclina sp., Gastropoda, Bryozoa and Red-algae were determined from the sandstones by TPAO research laboratory.

The Çamardı Formation is assigned to Paleocene-Eocene time interval by TPAO research laboratory on the basis of these fossils. The overlying Evliyatepe Formation of Lower to Middle Eocene age limits the uppermost age as Late Paleocene. However, the Çamardı formation is regionally accepted to be deposited during Upper Maastrichtian-Paleocene time interval (Göncüoğlu and others, 1991). The Çamardı Formation was first determined as a nonconformable sedimentary unit lying over the Niğde group by Göncüoğlu and others (1991) and Kuşcu (1992). It is correlated to the

Çamardı Çakıltası of Göncüoğlu and others (1991). It is totally different from the Çamardı Formation of Viljoen and İleri (1973) which is a metamorphic unit found equivalent to upper part of the Gümüşler Formation. It is also different from the Çamardı Formation of Yetiş (1978) which is equivalent to the Ovacık Formation of Göncüoğlu and others (1991) and Kuşcu (1992).

3.1.4 Evliyatepe Formation

The flysch-like sedimentary rocks exposed at Evliyatepe is named as the Evliyatepe Formation (Göncüoğlu and others, 1991). The outcrops are seen as patches covering the southern parts of the Evliya Tepe, Kışlabayır Tepe and Ortakaya Sırtı.

The Evliyatepe Formation overlies the Çamardı Formation with an angular unconformity at the Evliya Tepe and Kışlabayır Tepe. It is unconformably overlain by the Quaternary alluvial deposits.

The formation consists of conglomerates, alternation of sandstones-siltstones, silty-limestones and occasionally intercalations of shales. The conglomerates are polygenic, poorly sorted and graded, well supported by a grayish to yellowish sandy matrix and are well cemented by calcareous material. They are composed of angular, subangular and elongated metamorphic rock fragments of various sizes and types. The limestone fragments from the Aladağ Unit which are also reported in NE of Çamardı (Göncüoğlu and others 1991) and the quartzite from the Niğde Group are observed as coarse particles even coarser than boulder size. On the other hand, the amount of gneiss clasts increases towards the top of the sequence. The gneiss, quartzite and marble fragments from the underlying Niğde Group rocks and non-metamorphic Aladağ - type limestone particles are the main constituents of the conglomerates. Characteristically, no granodiorite fragments are seen within the conglomeratic levels. Comparatively, the percentage of the gneiss fragments are higher than the other fragments. The alternation of sandstones, siltstones and silty limestones and occasional shale intercalations transitionally overlie the conglomeratic levels with a coarse grained sandstone. The dominant fragments of the sandstones are from the Gümüşler Formation, especially from the gneisses and quartzites. The siltstones consist of fragments of quartz, feldspar, calcite, fossils and little amounts of unidentified rock. They occur as interbeds between the silty limestones.

Nummulites globulus, Nummulites sp., Assilina sp., Alveolina oblonga, Alveolina spp., Flosculina sp. were determined by E. Sirel (Göncüoğlu and others, 1991) in the samples collected from the silty and sandy levels of the Evliyatepe formation, indicating to Early Eocene (İlerdian-Ypresian). Disregarding its age, the Evliyatepe formation is correlated to the Kaleboynu Formation of Yetiş (1978) and to the Subatlı Formation of Gül and others (1984).

3.2 Rock Units of the Ulukışla Basin

3.2.1 Eskiburç Group

The sedimentary, volcano-sedimentary and volcanic rocks at the southern parts of the study area named as the Eskiburç Group (Göncüoğlu and others, 1991). It consists of Ovacık and Ulukışla formations.

The Niğde Unit; consisting of Niğde Group, Üçkapılı Granodiorite, Evliyatepe and Çamardı formations is thrust on to this group at the south of Ortatepe Sırtı, southeast of Evliya Tepe. The Eskiburç Group may be correlated to the Ulukışla Group of Oktay (1982).

3.2.1.1 Ovacık Formation

The Ovacık Formation is named by Dellaloğlu and Aksu (1986) at and around Ovacık at the northeast of Ulukışla. In the study area, it comprises (1) flysch-like sedimentary sequences and (2) chaotic mixture of sedimentary and volcanic rocks. The formation is characterized by large blocky outcrops with the appearance of a broken formation in the region. It displays an intertonguing relationship with the Middle to Upper Paleocene Ulukışla Formation according to Dellaloğlu and Aksu (1986), however, such relationships are only locally observed within the study area.

The flysch-like sedimentary rocks that form stratigraphically lower constituents of the formation are composed of clayey to micritic limestones with alternations of sandstones. The distribution and outcrops of the lithologic units are not uniform because of the blocky character of the unit. Commonly, silty limestones lie at the bottom with sandstones. They rarely alternate with thin bedded siltstones and volcanogenic units. The sandstones are commonly arkoses containing clasts of plagioclase and chlorite.

The chaotic mixture is characterized by large size blocks of reddish to violet silty limestones, micritic limestones, andesites and basalts within a silt-sand sized volcano-clastic matrix with shale interlayers. The volcano-clastic dominated sand to silt sized matrix, is found around the andesite and basalt blocks, the blocks and large fragments of massive and vesicular basalts with andesites are embedded within a sand-sized volcanoclastic matrix, whereas silty to sandy fine grained fragments of sedimentary rocks are dominant around the sedimentary rock blocks.

Planorotalites chapmani, Morozovella conicotruncana, Miliolidae sp., Globigerina triloculinoides, Heterohelicidae, Globorotalia pseudomonardi Globigerinidae, Rotalidae, Olistochoplax sp., algae and shell fragments were determined in the silty sandstones of Ovacık Formation within the study area by TPAO research laboratory indicating to Middle to Late Paleocene age. To the west of the study area, however this formation is shown to be deposited during Upper Maastrichtian-Upper Paleocene time interval (Göncüoğlu, 1985). The Ovacık Formation is the equivalent of the Güney Formation of Oktay (1982), and Çamardı Formation of Yetiş (1978). However, the depositional contact

described by Yetiş (1978) with underlying metamorphic rocks is not observed. Instead, a tectonical relationship was established between the Niğde Group and the Ovacık Formation.

3.2.1.2 Ulukışla Formation

The Ulukışla Formation is first named by Demirtaşlı and others (1975). It is composed of basalts, volcanoclastics and limestones (Karataş Limestone) (Göncüoğlu and others, 1991; Kuşcu, 1992). The formation crops out at the southern part of the study area, along the southeastern margin of the Niğde Massif.

The formation is overlain and underlain locally by the turbiditic sedimentary rocks of the Ovacık Formation at and around Ovacık and Ulukışla (Dellaloğlu and Aksu, 1986).

The basalts are mainly vesicular, grey to black in color, and weathered. White to beige calcite amygdules are easily seen by the naked eye. They are seriate textured porphyritic basalts constituting of phenocrysts of pyroxenes with finer grained groundmass plagioclases and altered pyroxenes, calcite, iron oxide, chlorite and zeolite as secondary minerals.

The volcanoclastic rocks are agglomerates and volcanogenic sandstones. They are exposed locally within the area covered by basalts at a small stream at the southwest of Çamardı. The alternations of basalt flows and volcanogenic sandstones are characteristics of the upper levels of the volcanoclastic unit. They are, then, overlain completely by the vesicular basalts.

The age of the formation can not be estimated directly due to lack of fossils. The age of the Ovacık Formation that is intertonguing with the Ulukışla Formation, is Late Cretaceous-Late Paleocene so the deposition of the unit is considered to be contemporaneous with the Ovacık Formation.

3.2.1.2.1 Karataş Limestone Member

The fossiliferous shallow marine limestones exposed as lenses within the Ovacık Formation is named as Karataş limestone member (Göncüoğlu and others, 1991). The limestones are generally underlain by vesicular basalts of the Ulukışla Formation.

The Karataş limestone member consists of gray to dark gray and sometimes beige colored limestones and conglomerate. The conglomerate is observed generally at the lower part of the limestone. The rounded vesicular basalts and beige to white rounded limestones are the particles within the conglomeratic unit. Sometimes the Limestone member starts directly with the carbonates on the volcanic rocks.

Laffitenia sp., *Loflusia* sp., were determined by TPAO research laboratory, within the limestones at the lower parts of the Ulukışla sequence indicating to Late Maastrichtian. The limestone bands in the upper part of the sequence, however, include *Miscellenae miscella*, *Alveolina* sp., *Disticoplax biseriatis*, *Globorotalia triloculiniodes*, *Planorbulina Cretae*,

which is indicative for Upper Maastrichtian-Upper Paleocene. The age is quoted as Late Cretaceous-Early Eocene by Dellaloğlu and Aksu (1986), Late Paleocene by Gül and others (1984) and Middle - Late Paleocene by Yetiş (1984). On the basis of the ages assigned, the age of the Karataş Limestone member is accepted as Late Maastrichtian-Late Paleocene.

The Karataş limestone member is correlated to the Güneydağı Formation of Demirtaşlı and others (1975), Başmakçı Limestone of Oktay (1982), Mavraş limestone of Yetiş (1978) and the Mavraş Member of Gül and others (1984).

4. STRUCTURAL GEOLOGY

The study area undergoes a continuous N-S compression since at Least Middle Eocene whereas compressional and tensional regime dominates the neotectonic period. Most of the structures within the area are part of neotectonic conjugate fault systems, namely, NW-SE trending dextral Tuzgölü Fault and NNE-SSW trending sinistral Ecemiş Fault systems. Six main neotectonic faulting trends are observed in the region (Kuşcu, 1992). Two neotectonic structures are of special interest as, the Üçkapılı Fault and the Celaller Thrust (Kuşcu, 1992).

4.1 Üçkapılı Fault

The Üçkapılı Fault trending N30-35W direction, is a normal fault. The rocks are highly deformed and mylonitized along the fault, although no off-set is clearly seen in the field. The general trend of the fault is more or less conformable with that of NW-SE trending faults of Hasandağ Fault zone which is a normal fault with a right-lateral component (Göncüoğlu and others, 1991; Toprak and Göncüoğlu 1991). Üçkapılı Fault is one of the the en echelon faults of the Tuzgölü Fault zone and is the southward extension of the Hasandağı Fault zone along which the Central Anatolian and Niğde Massif rocks are displaced (Toprak and Göncüoğlu, 1991). Therefore, it may be a normal fault with right lateral component and have been formed or reactivated in the same phase that formed the Hasandağı Fault set. Since it displaces the Miocene-Pliocene Cihanbeyli Formation outside the study area, It is younger than the Pliocene. The northward extension of this fault, the Hasandağı Fault displace the Pliocene ignimbrites in the vicinity of Derinkuyu (Göncüoğlu and others, 1991).

4.2. Celaller Thrust

The Celaller Thrust (Kuşcu, 1992) trends more or less N60-70E and dips moderately (30o-40o) northwards. The Niğde Group, Upper Maastrichtian-Paleocene Çamardı Formation and Lower-Middle Eocene Evliyatepe formation is thrust over the Late Cretaceous-Upper Paleocene Eskiburç Group (Figure 3) along this fault. The mylonitization, deformation, development of slaty cleavage on silty limestones of

Evliyatepe Formation and steeply dipping bedding planes along the fault, and mesoscopical recumbent to overturned folds developed in the clayey limestones of the underlying Ovacık Formation, are the evidences for this fault. The age of the this fault is post-Eocene and pre-Pliocene as Pliocene clastics to the west of the study area (Figure 2) cover the thrust. The Celaller Thrust provides critical evidence for the importance of the structures formed in the area where en echelon faults extending from Tuzgölü Fault set and Ecemiş Fault Zone intersects. The thrust in the area is probably resulted by the left lateral movement of the Ecemiş Fault.

All the macroscopic and mesoscopic structure on the Tuzgölü and Ecemiş Fault system are produced by present N-S compression (Toprak and Göncüoğlu, 1991). As a result, Celaller Thrust was developed possibly under this tectonic regime.

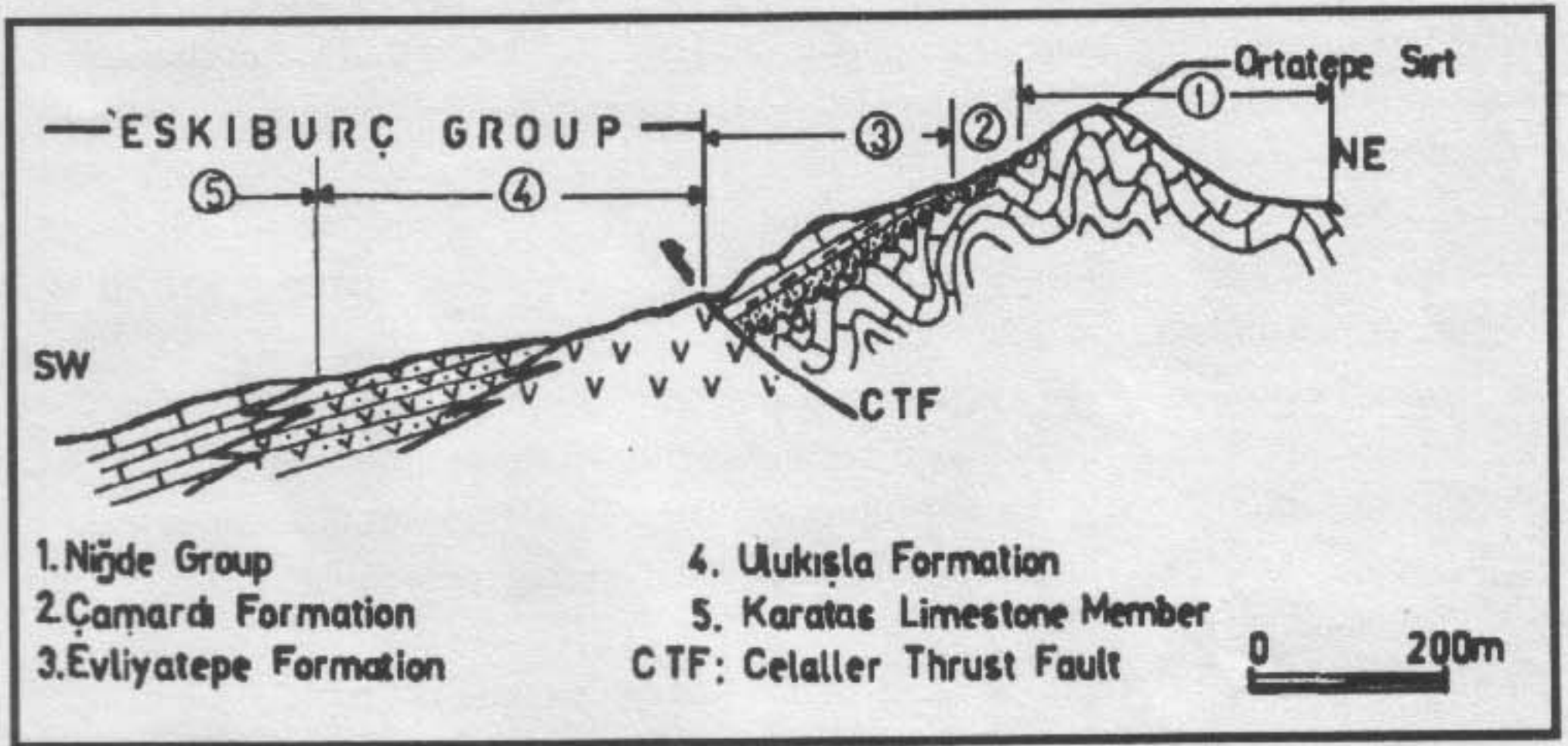


Figure 3. Sketch cross-section illustrating the contact relationships between Niğde Group, Çamardı, Evliyatepe formations and the Eskiburç Group.

5. CONCLUSIONS

The principal conclusions of the study are;

1. The study area is located to the south of the Niğde Massif and northeastern part of the Ulukışla Basin. The Niğde Group, and its cover (Çamardı and Evliyatepe formations) form the Niğde Unit. The Ovacık and Ulukışla formations belong to the rock units of the Ulukışla Basin.

2. In the Niğde Group, the Aşıgediği Formation site on the Gümüşler Formation over an unconformity.

3. The Üçkapılı Granodiorite of Cenomanian age intruding the metamorphic rocks has produced very weak contact metamorphic zone. Later cataclastic deformation and resulting mylonitization were superimposed on the rocks probably during post-middle

Eocene and pre-Pliocene period.

4. The oldest sediments of the non metamorphic cover of the Niğde Group to the north of Çamardı (Evliyatepe) dated as Lutetian by Yetiş (1978). New fossil data, however clearly indicates that the earliest deposition on the metamorphics is paleocene in age. The lower contact of the unconformably overlying flyschoidal sediments (Kaleboynu Formation of Yetiş (1978; 1984), Evliyatepe Formation in this work). On the other hand, yield fossils of İlerdian age, which shows that the transgression has started earlier than suggested in previous work (Yetiş, 1978; 1984).

Another critical finding in the study area is the presence of well-rounded pebbles and boulders of fossiliferous Aladağ-type limestones within the Evliyatepe Formation. (which directly overlies the Niğde Metamorphics). These data further supports the suggestion of Göncüoğlu and others (1991) that the Aladağ Unit and consequently the Taurides must have been located very close to the Niğde sub-Massif (during Early Eocene) of the Central Anatolian Crystalline Complex. This suggestion obviously discredits the presence of a wide Inner Tauride Basin during Early Eocene, which is advocated by some authors (Oktay, 1982, Görür and others, 1984).

5. It has been shown that Niğde group with its paraautochthonous cover (Çamardı and Evliyatepe formations) is in thrust contact with rock units of the Ulukışla Basin. Which was formerly considered to be a depositional contact (Yetiş, 1978; 1984).

6. The Cellaler Thrust Thrust is a neotectonic structure produced by present N-S compression within the area where Ecemiş and Tuzgölü (Hasandağ) fault zones make a conjugate system. The fault should be activated during post-middle Eocene and pre-Pliocene periods.

7. The Cellaler and Üçkapılı faults, as well as and other minor noteworthy faults in the region are the neotectonic structures. They have the similar general trends with the Ecemiş and Tuzgölü (Hasandağ) fault zones. This may indicate that the faults in the study area have a common origin with the Ecemiş and Tuzgölü (Hasandağ) fault zones.

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