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GEOLOGY OF THE İDİŞ DAĞI - AVANOS AREA (NEVŞEHİR - CENTRAL ANATOLIA)

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ABSTRACT.-İdiş Dağı-Avanos area is located on the northeast of Nevşehir, and is a part of the Central Anatolian Crystalline Complex.

The basement rocks of the study area constitue? Mesozoic aged Aşıgediği Metamorphics, that represent the uppermost unit of the Central Anatolian Metamorphics and consist of platform type meta-carbonates. İdiş Dağı Syenitoid, composed of quartz syenite, alkali feldspar quartz syenite and quartz monzonite intruded the Aşıgediği Metamorphics, and generated contact metamorphic zones. Karahıdır Volcanics are found as dykes cutting the İdiş Dağı Syenitoids and as blocks in the Göynük Volcaniclastic Olistostrome.

Göynük Volcaniclastic Olistostrome unconformably covers the basement rocks. It is formed within a fault-controlled extansional basin in Uppermost Cretaceous-Lower Paleocene period, and includes the olistoliths of the Karahıdır Volcanics and İdiş Dağı Syenitoids.

The late Lower Paleocene-Upper Paleocene Yeşilöz Formation consists of the Saytepe Conglomerate Member and the Asaftepe Member and represents the terrestrial and lacustrine depositional environment. Middle Eocene Mucur Formation characterising shallow marine (reefal) deposition transgressively overlies the basement rocks. It is suggested that in the Early Miocene, a compressional system effected the İdiş Dağı Area, and the basement rocks were thrusted over the Tertiary cover units.

The neotectonic period started in Late Miocene in the study area. In this period a new tensional system became effective, Ürgüp and Asarcık Formations are deposited within the basins which are controlled by the Central Kızılırmak Fault Zone. The Quaternary aged travertine occurrences and talus deposits are also related to this fault zone. The Karataş Volcanics and Kızılırmak River terraces of Quaternary of age are mainly controlled by the Central Kızılırmak Fault Zone.

INTRODUCTION

The study area is located to the northeast of Nevşehir (Fig. 1) in the Kırşehir Massif which is included in Central Anatolian Crystalline Complex (CACC) (Fig. 2), which comprises three large sub-massifs; Akdağmadeni to the east, Kırşehir to the west and Niğde to the south (Göncüoğlu et al., 1991).

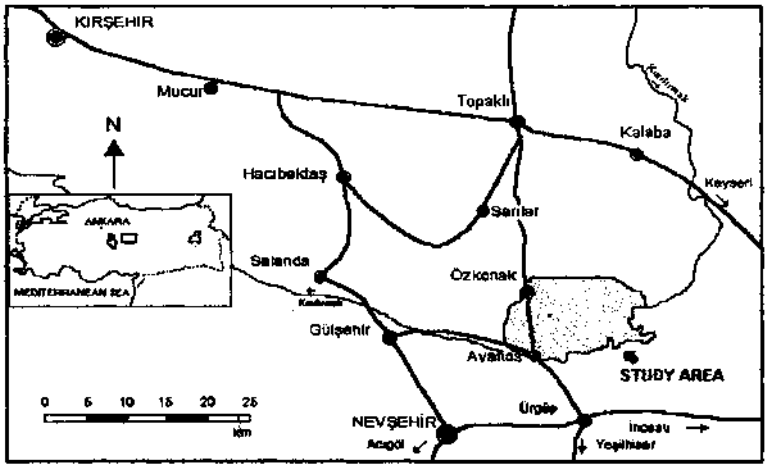

Fig. 1- Location map of the study area.

The metamorphic rocks in the CACC are defined as "Central Anatolian Metamorphics" comprising Gümüşler, Kaleboynu and Aşıgediği Metamorphics by Göncüoğlu (1977) and Göncüoğlu et al. (1991, 1992, 1993). These metamorphics were obducted by ophiolitic units which are named as "Central Anatolian Ophiolites" and both are intruded by plutonic rocks named generally as Central Anatolian Granitoids.

In the earliest work on the geology of the study area Pisoni (1961) suggests that the Paleozoic-Mesozoic aged marbles intruded

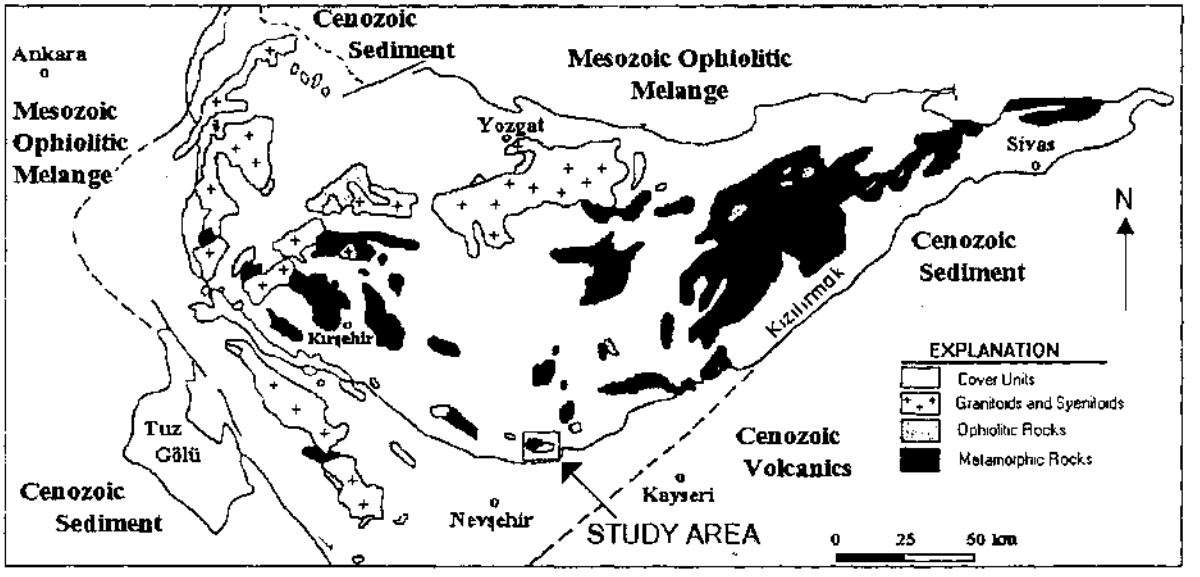

Fig. 2- Distribution of the main rock-units in the Central Anatolian Crystalline Complex (simplified from Bingöl, 1989).

by granitoids and/or syenitoids form the basement. They are covered by graywackes, marls and Nummulitic limestones of Eocene, graywackes, conglomerates and marls of Oligocene, and tuffs of Neogene age.

Aydın (1985) worked in the Gümüşkent (Nevşehir) area which is on the west of Avanos, and described alkaline plutonic rocks in the area. According to her, in the area the metamorphic rocks such as marbles, gneissic rocks and amphibolites are intruded by granitoids and syenitoids at a nearly shallow depth, and the volcanic rock types in the area were created from almost the same magma.

Atabey et al (1988) and Atabey (1989), studied the geology of the area around Avanos which also comprises the İdiş Dağı region, and mapped the area at 1/25 000 scale. According to him, in the İdiş Dağı area, the basement is Tamadağ and Bozçaldağ formations which belong to the Pre-Mesozoic aged Kaman Group of Seymen (1981). The basement is intruded by Pre-Campanian aged granitoids, The metamorphic and magmatic rocks of İdiş Dağı area are nonconformably covered by Saytepe and Lalelik members of Pre-Lutetian aged Ayhan Formation which is followed by Upper Miocene-Pliocene aged Tuzköy and Yüksekli Formations, Kavak Member of Ürgüp Formation and Quaternary cover units.

According to Göncüoğlu et al. (1993), Paleozoic-Mesozoic aged Central Anatolian Metamorphics which mainly consist of Gümüşler, Kaleboynu and Aşıgediği Metamorphics are the basement units in the Avanos area. Central Anatolian Metamorphics are intruded by Upper Cretaceous aged İdiş Dağı Syenitoid which is cut by Karahıdır Volcanics. These units are covered by Latest Cretaceous-Early Paleocene Göynük Formation, which can be defined as a volcaniclastic olistostrome followed by Middle-Late Paleocene Saytepe and Asaftepe members of Yeşilöz Formation. Mucur Formation is Early-Middle Eocene in age, and includes four members as Göbekli, Ayhan, Sarılar and Keklicek members. The Lower Miocene rocks (Akgün et al., 1995) in the surrounding region which are called as Gümüşyazi Group are not observed in the Avanos area. The Mio-Pliocene Kızılırmak Group rocks are deposited in the terrestrial basins which were formed in the neotectonic period, and composed of four contemporary and laterally transitional formations as Ürgüp (Pasquare, 1968), Asarcık, Seyfe and Akbayır.

Lulu (1993) described that in the Hırka Dağı (Gülşehir-Nevşehir) area, there are Paleozoic-Mesozoic Central Anatolian Metamorphic rocks,

Cenomanian Üçkapılı Granodiorite which intruded the metamorphics, and Tertiary Elmadere Olistostrome, which corresponds to the Göynük Formation and the younger cover units.

Toprak (1994), defined the fault set in İdiş Dağı area as one of the major fault sets which belong to the Central Kızılırmak fault zone. İdiş Dağı fault represents the northern margin of the Hırka Dağı-İdiş Dağı horst and southern margin of the depositional environment of the Asarcık Formation. According to Toprak (1994), Central Kızılırmak fault zone constitutes the northern margin of the Central Anatolian Volcanic Province which includes the several volcaniclastics intercalated with lacustrine to fluvial deposits.

In spite of these numerous geological works in Central Anatolia, there are still problematic points about the geological evolution of Central Anatolia and surrounding regions. The present research is aimed towards an understanding of the geological and petrological characteristics of the İdiş Dağı-Avanos area, considering this as one of the key regions of Central Anatolia.

Three very critical problems can be investigated in İdiş Dağı area in detail. The first important problem in the study area is the structural relationship of the rocks of Central Anatolian Crystalline Complex (CACC) with the Tertiary cover units. Secondly, the geological and petrological features of a volcaniclastic olistostrome which is one of the most important units in CACC, could be properly studied in the area. Besides these aspects, the geological and geochemical properties of the plutonic and volcanic rocks in the area are very criticai to understand the evolution of the Central Anatolian Crystalline Complex.

This work is mainly focused on the general geological aspects of the study area, to give the regional geological framework and thus an introduction for further work on petrology of the plutonic rocks (Göncüoğlu et al., 1995) of the study area.

ROCK UNITS OF THE BASEMENT

The basement rock units exposed in the study area can be divided into three main groups: 1) Central Anatolian. Metamorphics, 2) Central Anatolian Plutonic Rocks, and 3) Karahıdır Volcanics. The geological map and the stratigraphic columnar section of the study area are given in Fig. 3 and 4.

Central Anatolian Metamorphics

In the study area, the Central Anatolian Metamorphics are represented by an incomplete sequence of Aşıgediği Metamorphics.

AşıgediğiMetamorphics

In the İdiş Dağı area, Aşıgediği Metamorphics are characterized by massive marbles with amphibolite intercalations. Aşıgediği Metamorphics are observed as roof pendants on the plutonic rocks. It has a thrust fault contact with Paleocene-Eocene sedimentary cover. Miocene-Quaternary cover units uncorformably overlay this formation. To the south and north Aşıgediği Metamorphics is delineated by faults. In the study area, the marbles, amphibolites and some contact metamorphic rocks are observed.

Marbles

Marbles in the Avanos region are observed at the Ziyaret Tepe, and are also observed in Göynük Formation on the Lalelik Tepe as blocks.

Marbles are white colored and form topographically smoothed hills. Marbles are composed of micro and macrocrystalline calcite grains and characterized by massive structure. Along the thrust fault contact, to the northwest of the study area, marbles are cataclastically deformed.

Marbles are composed of interlocking calcite grains and show granoblastic texture. Two types of Marbles of Aşıgediği Metamorphics are differentiated according to their grain sizes macrocrystalline marbles with grain size of 0.3-2 cm and microcrystalline marbles with grain size of 0.1-0.3 cm. In the study area, marbles are generally formed from calcite, but minor amounts (upto 5 %) of quartz, K-feldspar and opaque minerals are also present. Calcite minerals are twinned. The effects of post-metamorphic deformation are detected microscopically. In the highly deformed samples, quartz and

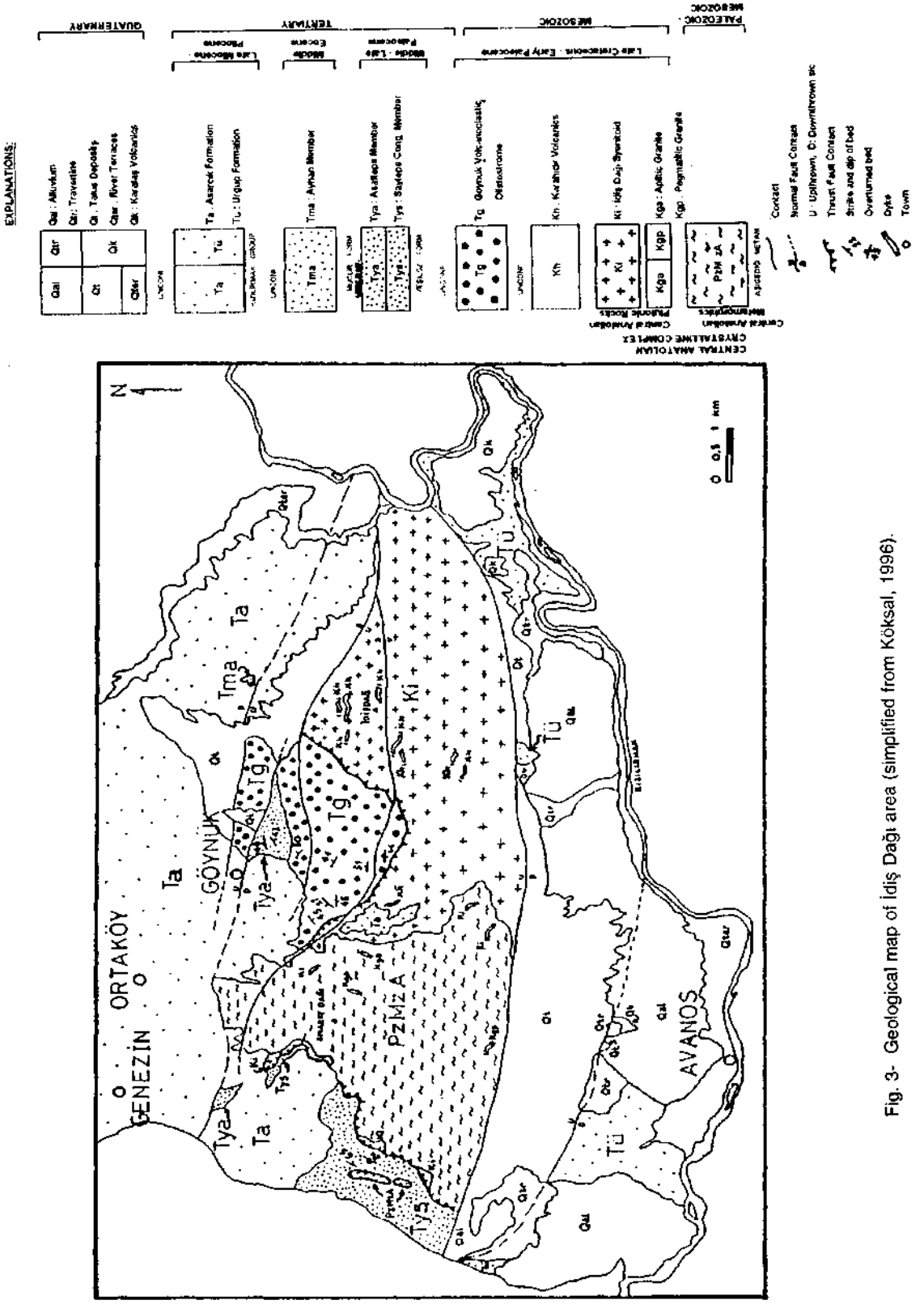

Fig. 3- Geological map of İdiş Dağı area (simplified from Köksal, 1996).

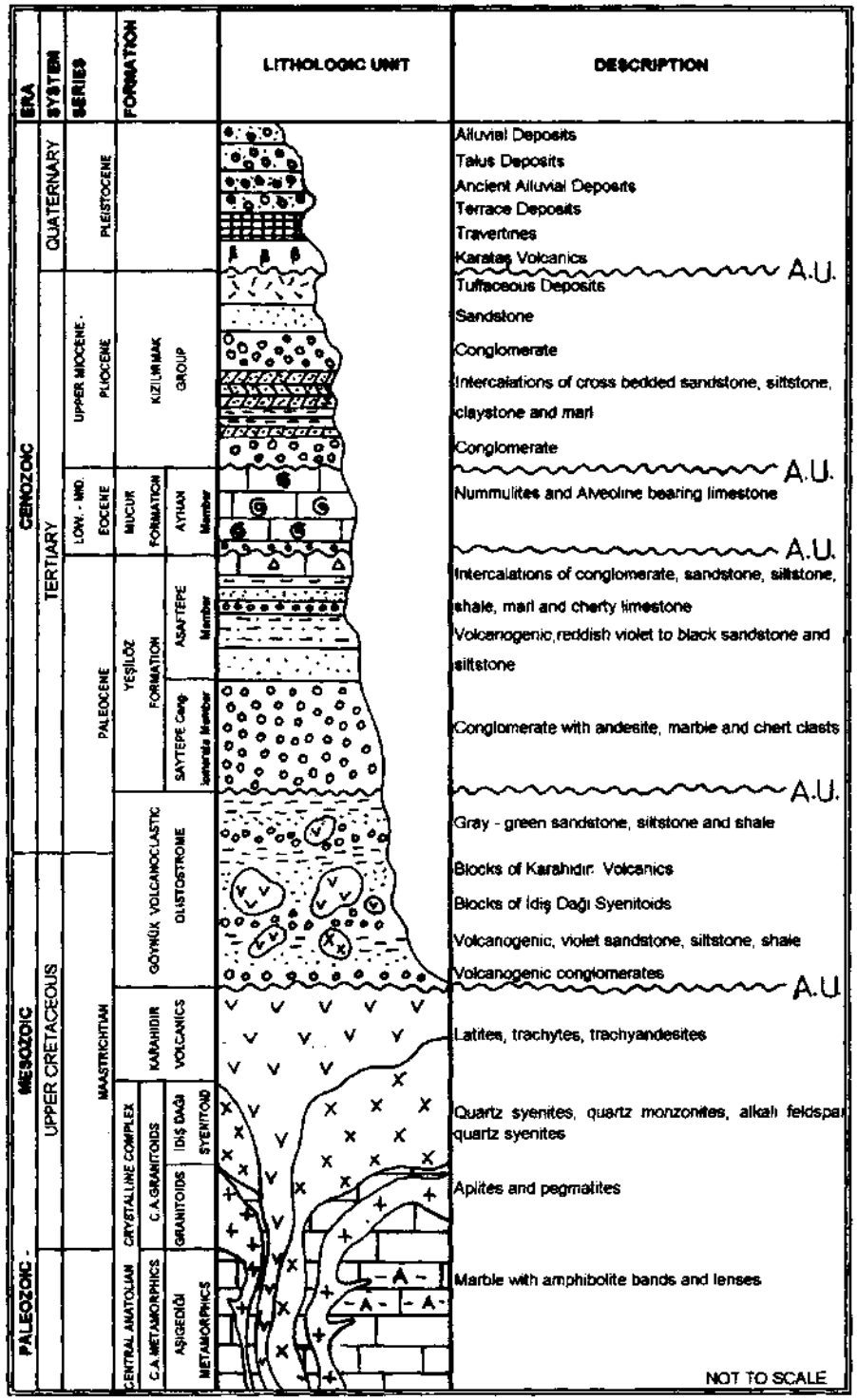

Fig. 4- Generalized colomnar section of the study area.

quartzo-calcitic lenses are observed between foliated calc-schist bands. The protolith of marbles in the area may be suggested as pure or slightly impure limestone.

Marbles are surrounded by the İdiş Dağı Syenitoids, and they are roof pendants on that body. Dykes of the İdiş Dağı Syenitoids, pegmatitic and aplitic granites are found in marbles. Along their contacts, marbles are macrocrystalline and highly silicified. At some parts contact metamorphic aeroles, between marbles and syenitoids, are also observed. At these contact metamorphic zones, hornblende-garnet hornfelses are found between syenitoid intrusions and coarse grained silica-bearing marbles. These hornfelses exhibit fine grained granoblastic texture. Amphibole-garnet hornfelses are composed of ~ 45 % Ca-garnet", ~ 42 % amphibole, ~ 10 % calcite, ~ 2 % quartz and ~ 1 % opaque minerals. Garnets are brown in color and of calcium type. Ca-garnets are idioblastic crystals, with about 0.5 mm diameter. They show anormous zoning due to the anomalous extinction. Amphiboles occur as smaller xenoblastic crystals, smaller than Ca- garnets. They show pleochroism from dark to light green or bluish green to green. Quartz and opaques are found as minor grains. Main paragenesis in these hornfelses is Ca- garnet+amphibole+calcite+quartz assamblage, which represent the medium grade contact metamorphic conditions (Winkler, 1979). At more northern contact zones vesuvianite and wollastonite minerals are also observed. In these samples vesuvianite + K-feldspar and wollastonite + K-feldspar + amphibole paragenesis are detected.

Amphibolites

Amphibolites and amphibole schists in the study area are found as interlayers confined in marbles. Amphibolite bands are found on the southern parts of the Ziyaret Tepe. Amphibolite bands are conformable with marbles, and intruded by alkaline dykes on the southeastern and by pegmatitic dykes on the southern part of the Ziyaret Tepe. In the hand specimen, amphibolites are dark grayish colored and contain hornblende, plagioclase and biotite. They are generally fine grained, but grains are larger at the contacts with dykes. The thickness of amphibolite bands changes from 5 to 70 cm.

In the study area, amphibolites have generally fine grained nematoblastic texture. The modal compositions of amphibolites are given in Table 1. Amphiboles are of hornblende type and are xenoblastic, with < 2 mm diameter, and interlocking minerals having well developed cleavages. They are pleochroic from light green to greenish brown. Plagioclases are xenoblastic and exhibit polysynthetic twinning. Sericitization is present on plagioclases. Biotites are characterized by fine grained xenoblasts and are pleochroic from light green or brown to dark brown.

They are distributed in distinct zones, and partly chldritized. Epidotes are also characterized by fine grained xenoblasts and are pleochroic from yellowish green to green. Andalusite occurs as colorless to reddish idioblasts in only one biotite-rich sample and is nearly idiomorphic.

Table 1 - Modal composition of amphibolite

Minerals Abundances	SK-78	SK-96
Hornblende	40	40
Plagioclase	35	20
Biotite	15	20
Quartz	3	5
Andalusite	-	10
Epidote	4.5	-
Chlorite	-	5
Zircon	0.5	-
Opaque	2	-

Paragenesis in amphibolites are,

Plagioclase (Labradorite) + hornblende + biotite + epidote + quartz

Plagioclase (Anorthite) + hornblende + biotite + andalusite + quartz

According to Winkler (1979), the Low grade-medium grade metamorphism boundary of mafic rocks is indicated by An 17 + Hb isograde. Since the plagioclases of the plagioclase + hornblende pair in the study area are labradorite and anorthite in composition, temperature must be of higher parts of

medium grade. In addition andalusite which is observed in some amphibol-rich rocks is the typical mineral for medium grade metamorphism. Thus, the metamorphism conditions of amphibolites are medium grade. The protolith of the amphibolites may be a marly sediment containing a mixture of clays and carbonate material.

Central Anatolian Plutonic Rocks

The plutonic rocks in the İdiş Dağı area can be classified into two main groups as syenitoids and granitoids.

İdiş Dağı Syenitoid

In the İdiş Dağı area, plutonic rocks with little amount of quartz, are defined generally as syenitoids. These rocks form the basement units together with the Aşıgediği Metamorphics in the study area. Göncüoğlu et al (1993) named these rocks as İdiş Dağı Syenitoids because of their typical and extensive occurrence in this area. İdiş Dağı Syenitoid is a large stock which form Ötedikme Tepe and the eastern part of Ziyaret Tepe. It also crops out in the western side of the Ziyaret Tepe. Dykes of İdiş Dağı Syenitoid are found in Aşıgediği Metamorphics.

İdiş Dağı Syenitoid is generally in yellowish-pinkish color. Around the Ziyaret Tepe, white-gray colored samples are found. In the hand specimen large crystals of alkali feldspars (up to 3 cm) with well developed tabular appearance and in minor amounts and in smaller grain size quartz, plagioclase, and biotite minerals are detected.

İdiş Dağı Syenitoid is considerably altered in most parts of the study area. As a result of weathering, syenitoids seem to have been disintegrated to yield syenitic soil which covers considerabJe areas in the field. Thus, these areas are accepted and mapped as syenitoid areas.

At the contacts With metamorphics, syenitoids are highly altered. Also olistoliths of syenitoids are found in volcano-clastic olistostrome. Dykes of Karahıdır Volcanics are observed within the İdiş Dağı Syenitoid. İdiş Dağı Syenitoid cut and uplifted the Aşıgediği Metamorphics as roof pendants. It has also thrust fault contact with both Göynük volcano-clastic olistostrome unit rocks and Paleocene-Eocene sedimentary rocks. Miocene-Quaternary sedimentary units covered this unit, İdiş Dağı Syenitoids are faulted in the northern and southern parts. Also there are faults within the syenitoid body.

İdiş Dağı Syenitoids are defined by Göncüoğlu et al. (1993) as post collisional intrusions. The plutonic rocks around Kırşehir (Seymen, 1981; Lunel, 1985; Bayhan 1987, 1988; Bayhan and Tolluoğlu, 1987; Erler et al., 1991; Tolluoğlu, 1993, Akıman, and Boztuğ, 1993), Ankara (Bayhan, 1989), Nevşehir (Aydın, 1985), Kayseri (Özkan and Erkan, 1994), and Ulukışla (Çevikbaş et a1.,1995) have some similar and different characteristics, and their spatial and temporal relations with İdiş Dağı Syenitoids has been discussed properly in Göncüoğlu et al. (1995a).

Granitoids

Granitic rocks observed within the Aşıgediği Metamorphics are mainly aplitic and pegmatitic dykes.

The aplitic dykes were observed in the southeastern part of the Ziyaret Tepe intruding marbles of Aşıgediği Metamorphics. They are fine grained, granular rocks white in color, Almost no mafic mineral is seen on the hand specimen while quartz, K-feldspar and plagioclase are detected. These aplitic dykes are about 1 m. in width and almost 10 m. in length.

Pegmatitic granites are found in the southeastern part of the Ziyaret Tepe both as dykes and sills. They are intruding both amphibolites and marbles of Aşıgediği Metamorphics. Amphibolite enclaves are observable within the pegmatitic dykes. Pegmatitic granites are coarse grained (more than 1 cm. in length) and white in color. They are almost totally formed from quartz and K-feldspar crysts as detected on the hand specimen, These dykes are about 1 m. in width and few meters in length.

Aplitic and pegmatitic granites are not observed in contact with İdiş Dağı Syenitoids in the study area. Göncüoğlu et al. (1992), however report that granitic rocks in CACC have been commonly

intruded by syenitoids. Since they intrude the Mesozoic Aşıgediği Metamorphies and nonconformably covered by Latest Cretaceous elastics they must be at least Upper Cretaceous in age as İdiş Dağı Syenitoids.

Karahıdır Volcanics

In the İdiş Dağı area volcanic rocks are found as blocks within the Göynük Volcaniclastic Olistostrome and dykes cutting İdiş Dağı Syenitoids. These volcanic rocks are classified as Karahıdır Volcanics by Göncüoğlu et al. (1993). This name was first used by Kara and Dönmez (1990) by considering their wide exposure around Karahıdır Village to the north of Kırşehir.

Karahıdır Volcanics in İdiş Dağı area are both cutting the İdiş Dağı Syenitoids especially around Ötedikme Tepe and observed as olistoliths in Göynük Volcaniclastic Olistostrome in the center of the study area. Huge olistoliths of these volcanics formed the Köydikmeni, Gedikkasi and Gözenekli Tepe within the Göynük Volcaniclastic Olistostrome (Fig. 5). Also lot of volcanic blocks are found in Göynük Volcaniclastic Olistostrome in variable scales reaching up to tens of meters.

Karahıdır Volcanics in the study area can be differentiated into trachytic, latitic and andesitic types according to their field occurences. Trachytes are pink-violet or violet colored and trachytic texture is recognizable with the lineation of about 1 cm long, white-pink feldspar crystals. Also biotite, and minor amounts of quartz and pyroxene are observed. Trachytes are observed both as blocks in the Göynük Volcaniclastic Olistostrome and as dykes cutting İdiş Dağı Syenitoids. In these dykes effective chloritization is observable.

Latites are gray-violet colored and fine grained. Minerals are not recognizible except few altered feldspar and small biotite grains. They are mainly jointed (joint spacing from 5 cm to 10 cm) and porphyritic. Latites are generally observed as large blocks in the Göynük Volcaniclastic Olistostrome. Argillization is very effective in latitic rocks.

Andesites are fine grained and dark violet in color. Porphyritic texture is observable with feldspar grains (upto 0.5 cm) in some samples. Andesites are generally found as blocks in the Göynük Volcaniclastic Olistostrome, but there are some andesitic dykes cutting İdiş Dağı Syenitoids also.

Depending on the contact relationships Maastrichtian-Lower Paleocene age interval is suggested for Karahıdır Volcanics (Göncüoğlu et al., 1993).

The occurrences of Karahıdır Volcanics in Sarıkaya-Karahıdır, Karaova and Karaburna are reported by Göncüoğlu et al. (1993). Köksal (1996) studied the petrographical and geochemical characteristics of the unit. Kötüdağ Volcanite (Seymen, 1981; Tolluoğlu, 1993) and volcanic rocks in Salanda area (Aydın,1985) reflects similar characteristics with Karahıdır Volcanics.

STRATIGRAPHY OF THE SEDIMENTARY COVER

The nonmetamorphic units unconformably covering the basement rocks in the study area are represented by Göynük Volcaniclastic Olistostrome (latest Cretaceous-Paleogene), Yeşilöz Formation (Paleogene) and Ayhan Member of Mucur Formation (Middle Eocene) which are unconformably covered by Kızılırmak Group of Upper Miocene-Pliocene age and Quaternary sediments.

Göynük Volcaniclastic Olistostrome

In the İdiş Dağı area, on the east and south of Göynük Village there is a blocky Volcaniclastic Olistostrome. This unit is defined as Göynük Formation by Göncüoğlu et al. (1993) because of its type locality and section around Göynük Village which is in the northeast of the study area. The unit is renamed as Göynük Volcaniclastic Olistostrome in this study (Fig. 4).

Göynük Volcaniclastic Olistostrome covers about 7 km^2 in the center of the study area, between Ziyaret and Ötedikme Tepes. Göynük Volcaniclastic Olistostrome can be defined generally as a volcano-sedimentary sequence with blocks of the basement rocks.

Göynük Volcaniclastic Olistostrome starts with massive conglomerates which dip towards south, under the syenitoid body due to the later thrusting (Fig. 5). Towards the north the conglomerates are followed by cross-bedded sandstone and siltstone layers. Beds of elastics are deformed and folded along Mesenin Stream Valley. In this area, there are syenitic and volcanic rocks which are surrounded by a matrix of conglomerate, sandstone, siltstone, and shale. The size of these ellipsoidal shaped blocks varies between 10-50 m.

volcanic block which formed Koydikmeni Tepe is about 2.5 km in length and is placed on top of the southern clastic series. On that block, to the north there are volcanic sandstone layers and smaller volcanic rocks.

The volcaniclastic rocks in the Göynük Volcaniclastic Olistostrome can be characterized as sequences of conglomerate-sandstone-siltstone-shale series. These rocks are composed of volcanic material derived from the underlying vol-

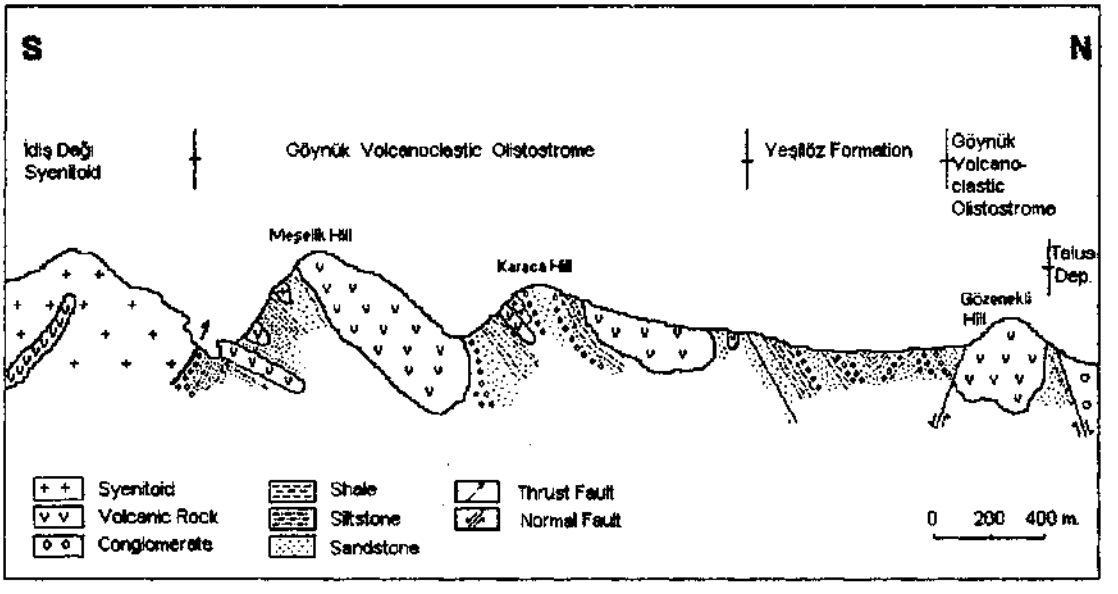

Fig. 5- Simplified cross-section from the study area showing the contact relationships of the Göynük Volcaniclastic Olistostrome.

The sandstones in the lower part of the unit are often violet or violet-gray colored and thin bedded. The conglomerates however, are massive to thick bedded, violet in color and contain rounded to subrounded, volcanic, syenitic and consolidated shale pebbles. The pebbles are generally grain supported and their sizes are up to 15 cm. The large volcanic olistolith on the Meşelik Tepe, is covered at the northern slope of the Meşelik Tepe, by an alternation of conglomerate, sandstone and siltstone. Towards the north, green colored flyschoidal sandstone and siltstones are observed. Another cycle of olistostromes with smaller syenitic and andesitic blocks is emplaced between the green flyschoidal elastics and volcanjclastics. The ellipsoidal shaped

canic blocks. Conglomerates are formed from trachyte, latite, andesite, syenite and chert clasts within a volcanogenic groundmass. In sandstones, siltstones and shales main minerals are K-feldspar, quartz and plagioclase. There are also lesser amounts of biotite, muscovite, chlorite, calcite, opaque and trace amounts of zircon exist.

K-feldspar in volcaniclastic rocks is of sanidine type and highly sericitized and argillized. It is generally represented by large subhedral crystals. Corroded and rounded quartz crystals with anhedral grain boundaries are observed. Biotites are pleochroic from yellowish green to dark green, and reddish brown to dark brown. Chloritization is

effective on biotites in some samples. Plagioclases are found as sericitized subhedral grains. On some grains 10° (indicating to a oligoclase composition) and 20° (indicating to an andesine composition) albite twinning angles are determined. Biotite and plagioclase can be detected as small grains in the groundmass in lesser amounts. Calcite is observed in veins and fractures. Zircon is present on some quartz, K-feldspar and plagioclase minerals as tiny inclusions.

There are no fossils observed in volcanosedimentary rocks. At its northern part Göynük Volcaniclastic Olistostrome unconformably overlain by the Yeşilöz Formation. Towards north, a south dipping normal fault juxtaposes Yeşilöz Formation and the Olistostrome. The part of Göynük Volcaniclastic Olistostrome observed at the north of this fault is in the same character with that in southern part. The volcanic block similar to that of Koydikmeni Tepe is observed on the Gözenekli Tepe and smaller blocks of similar lithologies are found on the Gedikkaşı Tepe. On the northern slope of Gözenekli Tepe elastics are dominant. Violet-gray and green sandstone, siltstone and shale layers and trachytic and latitic volcanics are found. On the north of Gözenekli Tepe the formation is cut by a fault which is named as İdiş Dağı Fault by Toprak (1994), after which only talus deposits are observable (Fig. 5).

Göynük Volcaniclastic Olistostrome is thrusted by İdiş Dağı Syenitoids at its southern part, and overlain by Paleocene-Eocene sedimentary rocks at its northern part. The thrusting of Aşıgediği Metamorphics to Paleocene-Eocene sedimentary rocks in the western part of the study area suggests that the Aşıgediği Metamorphics and İdiş Dağı Syenitoids together thrusted to Göynük Volcaniclastic Olistostrome. The thrust fault contact between syenitoids and Olistostrome is well detected in the Meşelik and Kurudere Valleys. Near to these contacts the bottom beds of the Olistostrome are overturned and dip beneath the syenitoid body, and this thrusting caused anticlinal folding at the southern parts of the Göynük Volcaniclastic Olistostrome. There are tear-faults which cut and displaced the thrust fault contact. At the east of the Göynük Village, on the north of Paleocene-Eocene sedimentary rocks, the volcanic rocks and clastic rocks of the Göynük Volcaniclastic Olistostrome are observed again. Thickness of the formation reaches up to 250 m. Clastic, members of Göynük Volcaniclastic Olistostrome suggest a fluvial environment. This formation is defined as underwater canyon deposits by Göncüoğlu et al. (1993).

Göynük Volcaniclastic Olistosrome is assumed to be formed in Upper Cretaceous-Early Paleocene period (Göncüoğlu et al., 4993) based on its similarity to Elmadere Olistostrome which is named and dated as pre-Danian by Göncüoğlu et al. (1991) in the south of Niğde. Lulu (1993) reported similar rocks in tectonic windows to the east of Hırkadağ, a few kilometers to the west of the study area, and described them as Elmadere Formation.

Tertiary Sedimentary Rocks

In the study area, large parts are covered by Tertiary sedimentary rocks. In the central part, on the north of Köydikmeni Tepe, these rocks start unconformably over the Göynük Volcaniclastic Olistostrome while in the western part around Lalelik Tepe, they are found as thrusted directly by the basement rocks. These rocks are defined as Yeşilöz Formation by Göncüoğlu et al. (1993). On the north, there is a fossilliferous limestone patch, which is defined as Mucur Formation by Göncüoğlu et al. (1993). Moreover, in the further northern and southern parts there are rocks defined as Kızılırmak Group. All these three different rock groups are Tertiary in age (Göncüoğlu et al. 1993). The same nomenclature will be used in this study.

Yeşilöz Formation

Yeşilöz Formation is represented by debris or mud flow consisting of volcanic and metamorphic clasts at the lower, and shallow marine and terrestrial rocks at the upper parts. Yeşilöz Formation is named depending on its type locality around Yeşilöz Village (Göncüoğlu et al. 1993), The formation covers about 4-5 km$^{\circ}$ in the western and central part of the study area.

Yeşilöz Formation is differentiated into two members as Saytepe Conglomerate Member and Asaftepe Member. Saytepe Conglomerate Member can be defined as the thick conglomeratic parts,

and Asaftepe Member as the overlying conglomerate, sandstone, siltstone, shale, marl and cherty limestone intercalations in the Yeşilöz Formation.

Saytepe Conglomerate Member

The thick conglomeratic part of the Yeşilöz Formation is named as Saytepe Conglomerate Member (Göncüoğlu et al., 1993, 1994a). Saytepe Conglomerate Member is observed in the middle part of the İdiş Dağı area on the north of Köydikmeni and Karaca Tepe, and also in the western part of the study area on the east of Lalelik Tepe. The base of this formation is observable in the central part of the study area on the Göynük Formation as the conglomeratic level having volcanic and chert clasts. This level comprises interlayers of thin layered dark grayish violet to black colored voleanogenic sandstone and siltstone through the upper parts. Saytepe Conglomerate Member is thicker on the western part of the study area. In that part, beds are nearly vertical and reverse graded because of overturning by the thrusting of İdiş Dağı Syenitoids and Aşıgediği Metamorphics. Marble clasts are observable in conglomerates in that part also. Conglomerates of the Saytepe Conglomerate Member are poorly sorted and rounded to subrounded, ranging from small (1 cm) to large (up to 20-30 cm) in size, Matrix is formed by alteration of dominating volcanogenic clasts violet to violet-red in color. Sandstones and siltstones are also volcanic in origin and reflect the same colors with the conglomerates.

Saytepe Conglomerate Member conformably overlies the Göynük Volcaniclastic Olistostrome and conformably overlain by the Asaftepe Member of the Yeşilöz Formation. The thickness of the Saytepe Conglomerate Member in the study area is about 20 m. Features of the member suggest that Saytepe Conglomerate Member is formed as debris flow, and the clasts are from the underlying formations abundantly from the Karıhıdır Volcanics.

Asaftepe Member

The conglomerate-sandstone-siltstone-shale^ marl intercalations with cherty limestone interlayers overlay the Saytepe Conglomerate Member in the study area. This unit is defined as the Asaftepe Member of the Yeşilöz Formation by Göncüoğlu et al. (1993).

In the central part of study area, Asaftepe Member starts with thin layered green-gray colored voleanogenic sandstone. It contains conglomeratic interlayers which contains clasts up to 30 cm in size. After a thin conglomeratic level, violet-gray colored conglomerate-sandstone- siltstone and shale intercalations start. More than five repetitions of these intercalations are detected. In most of them, transitional levels as conglomeratic sandstone, sandy siltstone and shale are abundant. Lithic tuff layers are present in few parts. The unit is generally thin layered, but in some parts thick layers (up to 20 cm) exist. Through the upper levels green-gray colored sandstone- siltstone layers are observable. Conglomerates are formed from subrounded volcanic clasts supported by a fine grained sandy to silty matrix. Cross-bedding is observable on sandstone layers. Small scale faulting and folding exist in beds of Asaftepe Member. Slickensides, calcite veins and mud cracks are observed on these beds. Recumbent foids and small scale slumps are detected in Asaftepe Member.

In the western part of the study area around Lalelik Tepe, beds of Asaftepe Member are observable over the conglomeratic sandstone layers of Saytepe Conglomerate Member. Thick bedded (about 20 cm) violet siltstone with thin fissile shale interlayers are the first observable beds of Asaftepe Member in that part. There are gray, algea-bearing clayey limestone lenses of few meters in size within these beds. On top of these beds, brownish shale, green siltstone-marl and violet siltstone layers exist alternatively. There are lenses of pink-gray colored algeal limestone with chert bands. These lenses reach up to 30 meters in thickness and are conformable with underlying and overlying beds. Overlying beds are gray colored, thick bedded (about 30 cm) sandstone and violet colored conglomeratic sandstone. Conglomerates are unsorted and from mm size to 15 cm in diameter. Conglomerates are mainly volcanic in character.

In the northwestern part of the study area, in the Kireçlik Valley pinkish sandstone-siltstone and

pink-gray clayey limestone beds are observed. These beds belong to Asaftepe Member and represent the upper parts of this member in the study area. On the Lalelik Tepe, on top of the rocks of Asaftepe Member there are klippen of marbles of Aşıgediği Metamorphics (Fig. 6). Intensive brecciation and slickensides and are detected on siltstone beds of Asaftepe Member formed during the overthrusting of the basement rocks onto the Yeşilöz Formation. Along the contacts of the klippen with the elastics of the Asaftepe Member, the underlying sandstones are squeezed and crushed, and the pebbles of the conglomerates are polished and broken.

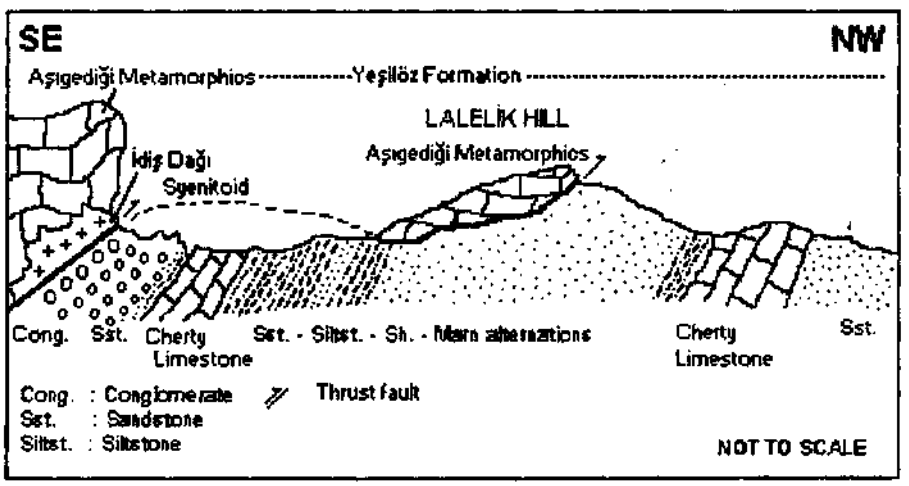

Fig. 6- The structural relationships of Yeşilöz formation and the basement rocks in the NW of the study area.

Detailed petrographical work carried out on the sandstones, siltstones and shales of this unit shows that the rocks fragments are composed mainly of Karahichr Volcanics with some clasts of ophiolithic rocks. The main minerals in these rocks are K-feldspar and quartz. There are also lesser amounts of biotite, muscovite, plagioclase, chlorite, calcite, epidote and opaque and trace amounts of zircon and apatite exist. In fine grained samples the same mineralogical composition but turbiditic character is determined. In lithic tuffs, grains are somewhat larger, but matrix is almost unrecognizable. K-feldspar, plagioclase, quartz, biotite and opaques are observed in lithic tuffs. Chlorite is the secondary mineral in lithic tuffs.

No microfossils are recognized in these rocks.

The thickness of the Asaftepe Member in the study area is determined approximately as 150 m. Asaftepe Member represents the lacustine to shallow marine rocks deposited in a basin of which filled by the fluvial Saytepe Conglomerate at the lower levels.

The depositional age of Asaftepe Member is accepted as Late Lower Paleocene- Early Upper Paleocene, depending on its lithologic similarities and stratigraphic position with the fossiliferous (Algea and Ataxophragmidae; det: E. Sirel in: Göncüoğlu et al., 1991) Karataş Limestone Member of Eskiburç Formation to the south of the study area.

Mucur Formation

In the İdiş Dağı area, on the north of Dalak Tepe there are massive limestones which contain Alveolines and Nummulites fossils. On the west of study area around Ayhan village, the units with the same character are defined as Ayhan Member of Mucur Formation by Göncüoğlu et al. (1993).

Mucur Formation uncorformably overlies Yeşilöz Formation, and transgressivly covers the basement rocks of the Central Anatolian Crystalline Complex. Mucur Formation is Early-Middle Eocene in age, and consists of four members: Göbekli Conglomerate Member (shallow marine), Ayhan Limestone Member (reefal), Sanlar Flysch Member (deep marine) and Keklicek Limestone (shallow marine-lacustrine) (Göncüoğlu et al., 1993).

Limestones of Ayhan Member in the study area are clayey, white gray in color, brittle and having macrofossils of 1.5-2 cm in diameter. Fusiform and

cylindrical Nummulites and Alveolina fossils are recognizible. In the fossiliferous limestones of the Mucur Formation, *Alveolina* sp. and *Nummulites* sp. fossils are dominant. There are also *Assilina* sp. fossils observed in these rocks. There are pellets and peloids observed in fine-medium grained matrix which is fonned from calcite. These limestones can be classified as bio-pelsparite.

Ayhan Member is unconformably overlain by the rocks of Kızılırmak Group. The thickness of the member is about 30 m in the study area.

By the paleontological works, the age of Ayhan Member is found as Middle Eocene (Lutetian) (Göncüoğlu et al., 1993). It can be compared with the Lutetian aged Boztepe Member of Altınpınar Formation of Atabey et al, (1988).

Kızılırmak Group

The younger terrestrial units unconformably covering the Paleogene sediments in the study area are named as Kızılırmak Group and defined as Mio-Pliocene in age (Göncüoğlu et al., 1993).

Although the units of Kızılırmak Group are concurrent, the differences in depositional environment give way to distinguishing of different formations which are transitional laterally. Two of these formations are observable in the Avanos area: Ürgüp and Asarcık Formations. (Pasquare, 1968; Göncüoğlu et al., 1993, Toprak, 1994).

Ürgüp Formation

The volcano-sedimentary deposits on the southern side of İdiş Dağı belong to the Ürgüp Formation, which is named by Pasquare (1968). These are formed from several pyroclastic levels intercalated with sandstone and claystone bearing, tuffaceous fluvial-lacustrine sediments. Intercalations of cross bedded sandstone, thin bedded siltstone, laminated claystone and marl are detected in the Ürgüp Formation. The sediments are generally gray in color, but in some parts reddish sandstone-siltstone-claystone alternations transitional with grayish sandtone-siltstone- clay stone-marl alternations, are observed.

Temel (1992), worked in the region which is on the south of the İdiş Dağı Area. He differentiated the Kavak, Zelve and Çökek Members of the Ürgüp Formation along the southern bank of the Kızılırmak River. The continuation of these members are observed in the study area. Kavak Member is observed in the southwestern, Zelve Member is observed in the southern and Çökek is observed in the southeastern part. Kavak and Zelve Members are ignimbritic in character, and Çökek Member is formed from intercalation of clayey-carbonaceous units and tuffites.

The bottom part of Ürgüp Formation is not observed in the study area, but the contact along the Salanda Fault (Toprak, 1994) with İdiş Dağı Syenitoids is present in the eastern parts. Salanda Fault is generally east-west elongated, and dip of the fault plane changes from 58°-84° S. The other faults in the İdiş Dağı area, are synthetic or antithetic with the Salanda Fault. Ürgüp Formation is unconformably overlain by the Karataş Volcanics, river terraces, alluviums and talus deposits. Its thickness is about 120 m in the study area.

Ürgüp Formation is deposited in a basin bounded by the Central Kızılırmak Fault Zone (especially Salanda Fault) at the north. The depositional environments are fluvial and lacustrine. According to radiometric age datings (Innocenti et al., 1975), Ürgüp Formation is 10 ± 3 ma (Late Miocene-Pliocene) in age.

Asarcık Formation

Asarcık Formation (Göncüoğlu et al., 1993, Toprak, 1994), covers large areas on the northern part of the study area. It consists of pyroclastic and epiclastic levels. The thick tuffaceous layers are the most characteristic features in Asarcık Formation. Also white-gray colored, medium- fine grained sandstone and conglomerate levels are observed.

In the Avanos area, Asarcık Formation unconformably overlies the units of Eocene and older age. There are restricted outcrops of tuffs of Asarcık Formation in the central part of the study area. Asarcık Formation is unconformably covered by Quaternary river terraces, alluviums and talus deposits. Its thickness in the area is about 70 m.

Asarcık Formation represents the lacustrine and fluvial environments. It is accepted as concurrent with Ürgüp Formation (Upper Miocene-Pliocene in age) by comparison of some tuff layers with the Ürgüp Formation (Göncüoğlu et al., 1993).

Quaternary Units

The units unconformably overlying the Mio-Pliocene and older units in the study area are defined as Quaternary Cover Units. These are basalts of Karataş Volcanics, travertines formed in the vicinity of active faults, terraces near Kızılırmak River, alluviums and talus deposits.

Karataş Volcanics

The basaltic lavas in the southeast of the idis Dağı area are named as Karataş Volcanics (Göncüoğlu et al., 1993).

The basalts of the Karataş Volcanics cover 2.5-3 km^2 in the study area. They are brownish black in color. These are hard and massive basalts with cooling joints.

On the hand specimen, large plagioclase, pyroxene and amphibole minerals are seen. Trachytic texture is also observable. These volcanic rocks are named as olivine basalt according to their mineralogical composition. These rocks are composed of plagioclase, clinopyroxene, hornblend, olivine and opaque minerals. Plagioclase is the dominant mineral in the olivine basalt of Karataş Volcanics. Plagioclases occur both as phenocrystals and as small grains. They generally exhibit euhedral crystal outlines and typical polysynthetic twinning. The maximum extinction angle in albite twins varies between 44° to 53°, representing bytownite and anorthite composition. Clinopyroxene occurs as subhedral crystals green in color. Clinopyroxenes reflect oblique extinction with about 27 suggesting a pigeonite type. Amphiboles occur as smaller crystals and are generally green in color. Epidotes are secondary minerals, found as small grains as amphiboles. Olivines are observed as subhedral to anhedral crystals and are replaced and surrounded by yellowish green iddingsite.

The basalts of the Karataş Volcanics unconformably and horizontally overlay the ignimbrites of the Ürgüp Formation. Thickness of the Karataş Volcanics reaches up to 10 m in some parts of the study area. The Karataş Volcanics reflects similar characteristics with the Kızıldağ Basalts of Atabey etal. (1988).

Travertines

In the Avanos area, especially along the Central Kızılırmak Fault Zone and along small scale active faults cogenetfc with the Central Kızılırmak Fault Zone, there are large travertine occurences (Göncüoğlu et al., 1993, Toprak, 1994).

GEOLOGICAL EVOLUTION OF AVANOS-İDİŞ DAĞIAREA

The İdiş Dağı-Avanos area represents the main geological characteristics of CACC with its complexity in petrographidal, mineralogical and structural features.

In the study area, the basement rocks are the Aşıgediği Metamorphics which belong to Central Anatolian Metamorphic Rocks, and granitoids and İdiş Dağı Syenitoids which belong to Central Anatolian Plutonic Rocks.

The Aşıgediği Metamorphics is found as an incomplete sequence. The massive marbles, are the parts of the metacarbonates of the Aşıgediği Metamorphics, and represent the platform type carbonates of Mesozoic age according to Göncüoğlu (1977) and Göncüoğlu et al (1993).

In the İdiş Dağı Area, the Aşıgediği Metamorphics are roof pendant on the plutonic rocks and also intruded by them. The plutonic rocks are generally named as Central Anatolian Plutonic Rocks, and differentiated into the granitoids and İdiş Dağı Syenitoids. Granitoids are the pegmatite and aplitic granites, and are found as intrusions in the Aşıgediği Metamorphics.

The formation of the Göynük Volcaniclastic Olistostrome is very probably related to a fault-controlled basin formed during Late Maastrichtian-Early Paleocene. In the Göynük Volcaniclastic

Olistostrome, large blocks of İdiş Dağı Syenitoids and Karahıdır Volcanics are observed. These blocks might have been broken away from the sides of the basin by the tensional faults during the basen formation. At the edges of these blocks the effects of the cataclastic deformation and relict parts of the trachytic-latitic volcanics are observable.

In the study area, Göynük Volcaniclastic Olistostrome is unconformably covered by the Yeşilöz Formation which represents the late Lower Paleocene-Upper Paleocene period. The Yeşilöz Formation is overthrusted by the basement units in the western part of the area. Areal distribution, contact relations and field characteristics suggest that the basement rocks were originally covered transgressively by Yeşilöz Formation which reflects fluvial deposition in its lower part and lacustrine depositional environment. The dominance of alluvial fan-apron type elastics and turbidites in Yeşilöz Formation indicates to a continental deposition in a technically subsiding intra-mountain basin.

The Ayhan Member of the Mucur Formation characterizes the Middle Eocene period in the study area. The limestone in, this member is reefal in character, but the contact relationship with older units could not be detected. However, in other,parts of CACC, Mucur Formation is observed to overly the Yeşilöz Formation with an angular unconformity (Fig. 3).

According to Göncüoğlu et al. (1993, 1994a, 1994b), in the Middle Eocene period, a compressional regime was effective in the Central Kızılırmak Basin which is just to the north of the study area. According to them, in this period transgression occurred and a new northward dipping basin was formed. Olistostromes and huge basement olistoliths placed from south into this basin in which deep turbidites were deposited. Since the deposits containing these olistoliths are Middle Eocene in age, this event must have been occurred in Middle Eocene. The south-north directed compression was continued during Early Miocene period, and asymmetric basins filled by Gümüşyazı Group were formed in the region (Göncüoğlu et al. 1993,1994a,1994b; Akgün at al., 1995) The rocks, of this period are not observed in the İdiş Dağı area.

The thrusting of the Aşıgediği Metamorphics together with the İdiş Dağı Syenitoids to the Tertiary Cover Units in the mapped area, is probably related to the terminal period of this compressional regime. Along the thrust contact, rocks are cataclastically deformed. The klippen of the marbles of the Aşıgediği Metamorphics on the Eocene Units in the western part of the study area is a result of this compression. The overturned basal units of the Göynük Volcaniclastic Olistostrome in Meşeliğin Dere as well as the folds observed in the Göynük Volcaniclastic Olistostrome and Yeşilöz Formation show that the compression is directed from south to north. Regarding the position of the klippen in Lalelik Tepe, the amount of the basement thrusting is at least 350 meters.

In the study area, in the Upper Miocene, the neotectonic period started. The rocks of the Kızılırmak Group (Ürgüp and Asarcık Formations in the study area) were deposited within the basins developed by the west-east trending grabens unconformably over the folded and deformed older units. The faults forming that horst-graben system are oblique in character and belong to Central Kızılırmak Fault Zone (Dirik and Göncüoğlu, 199S). The extrusion of the Karataş Volcanics is very probably related to the main fault of this fault system. Some of the splays of the fault zone are covered by the Plio-Quaternary rocks in the study area.

The presence of active travertine occurences shows that the faults of the Central Kızılırmak Fault Zone are still active. Quaternary age talus deposits and alluvial fans were also formed due to these faults.

CONCLUSIONS

İdiş Dağı-Avanos region is a critical area to study the characteristics of the Tertiary cover units and their relationship to the basement rocks of the Central Anatolian Crystalline Complex.

The basement rocks in the study area consist of Aşıgediği Metamorphics constituting the upper part of the Central Anatolian Metamorpics which is intruded by granitoids, İdis Dağı Siyenitoids and Karahıdır Volcanics of the Central Anatolian Plutonics, respectively.

The basement units are unconformably overlain by Göynük Volcaniclastic Olistostrome which consists of olistostromes with basement blocks of variing size. It is suggested that this unit has been deposited during Late Maastrichtian-Early Paleocene period in one of the numerous fault- controlled extansional basins in central Anatolia (Göncüoğlu et al., 19936, 1994a, 1994b, 1995b), indicating that the region was effected by tansional or trans-tansional regime. The presence of late- stage monzonitic-syenitic products of the Uppper Cretaceos Central Anatolian Plutonism with obvious geochemical fingerprints of a tectonic setting related to post-collisional extension (Göncüoğlu et al., 1994a, 1995a, Erler and Göncüoğlu, 1995).is a further support for our suggestion.

Alluvial fan-apron-type elastics and turbidites of the late Lower Paleocene-Upper Paleocene Yeşilöz Formation indicate to continental deposition on a regionally uplifting basement. Ayhan Member of the Middle Eocene Mucur Formation is represented by reefal limestones. This member transgressively overlies all the preexisting units and indicates to a transition from continental to marine depositional environment.

The İdiş Dağı basement rocks are thrusted at the end of Middle Miocene onto the Tertiary sediments which is ascribed to the compressional tectonics in the study arae that started already during Middle Eocene and reached its peak in late Middle Miocene. The overthrusting in the Avanos area is directed from south to north where the Aşıgediği Metamorphics are transported as a thrust-sheet at least 350 ms onto the Yeşilöz Formation.

Rock units of the Upper Miocene-Pliocene Kızılırmak Group unconformably cover the thrust contacts and have been deposited in small, east-west trending graben-type fluvio-lacustrine basins. The fault system generating the grabens and the İdiş Dağı horst is part of the Central Kızılırmak Fault Zone of Toprak (1994). The main fault to the south of İdiş Dağı is still active and is related to the extrusion of Quaternary Karataş Volcanics.

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