THE GEOLOGY OF THE AĞVANİS METAMORPHIC ROCKS AND NEIGHBOURING FORMATIONS

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ABSTRACT.— The area studied is located in Northeast Anatolia between the Pontide and Tauride orogenic belts. The metamorphic rocks called Ağvanis Group are bounded to the north and south by faults of the North Anatolian Fault Zone; in the east and west they are unconformably overlain by sedimentary rocks of Eocene and younger age. The Ağvanis Group consists mainly of metabasic rocks with lesser amounts of marble, phyllite, metadacite and metaacidic plutonic rocks. The major metaacidic pluton is the Gökseki metatrondhjemite which forms a large sheet. Metamorphic and surrounding rocks are cut by hundreds of dacite sills, stocks and a quartz-diorite pluton related to Paleocene acid magmatism. The western part of the Ağvanis Group forms a WNW-ESE trending large anticlinorium whereas in the east N-S trending antiform and synforms, probably as part of older structural elements, are preserved. Metamorphic rocks of the Ağvanis Group have undergone regional metamorphism in greenschist facies; a contact metamorphism superimposed on the regional metamorphism has developed around the quartz-diorite pluton. In terms of lithology, stratigraphy and type of metamorphism rocks of the Ağvanis Group resemble those of the Tokat Massif and probably constitute, like the Tokat Massif, the basement to the Pontide Mesozoic sequence. Hacıören Formation of Liassic age consisting of volcano-clastic sediments occurs to the north of the Ağvanis metamorphic rocks; whereas to the northeast of the Ağvanis metamorphic rocks there is the newly described Taşdemir Formation consisting of olistostromes of Paleocene age. Taşdemir Formation is tectonically overlain by the Boynuktepe Group which forms a nappe of Jurassic-Cretaceous limestones. Eocene sandstones lie unconformably on the Ağvanis metamorphic rocks and on the Taşdemir Formation. The youngest rocks in the area are terrigenous deposits probable of Oligomiocene age and poorly consolidated sandstone conglomerate, clay, marn and basalts of Neogene age.

INTRODUCTION

Tauride and Pontide orogenic belts which are separated in the Western and Central Anatolia by the Central Anatolian Metamorphic Massif, converge near Erzincan. In this region between the towns of Suşehri and Refahiye metamorphic rocks form a chain of hills 40 km long and 7-8 km wide extending in a ESE-WNW direction; these are named by Nebert (1961) as the «Ağvanis schist mountainchain». Nebert (1961), who mapped the basic geological features of a large region in Northeast Anatolia including the studied area, regarded the metamorphic rocks as the basement to the Pontide Mesozoic sequence. Bergougnan (1980, written communication), who worked later in the area, suggests that Ağvanis metamorphic rocks may represent a metamorphosed Pontide Mesozoic sequence. An altogether different interpretation is that the metamorphic rocks may be a pre-Jurassic ophiolite sequence (Şengör et al., 1980). Such variety of interpretations originates from the scarcity of geological data for this region. In order to establish the stratigraphic and tectonic setting of the Ağvanis metamorphic rocks, their stratigraphical, lithological and metamorphic features are studied in detail and a 1:25 000 scale geological map of the area was prepared.

The first study on the Ağvanis metamorphic rocks has been done by Nebert (1961), who delineated the metamorphic rocks on the map and gave a general description of the rock types. Gedikoğlu (1976) mapped the central part of the Ağvanis metamorphic rocks.

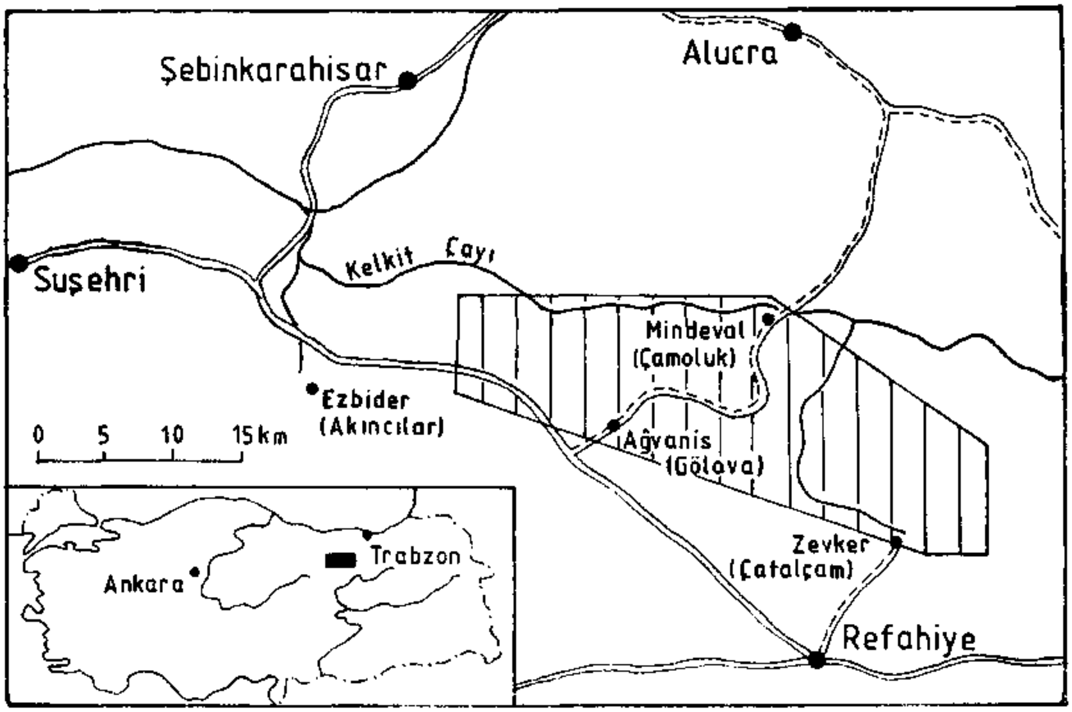

Fig. 1 - Location map of the studied area.

GEOLOGICAL SETTING

The Eastern Pontide Mesozoic sequence, which extends from Lias to Paleocene, is situated to the north of the Ağvanis metamorphic rocks (Pelin, 1977). In the south the Eastern Pontide sequence is absent and instead there is a tectonic complex of peridotite, spilite, chert and metamorphic rocks which occupy large areas (Tatar, 1975). Eocene sediments cover unconformably all the three basic units — Pontide Mesozoic sequence, Ağvanis metamorphic rocks and ophiolite complex— of the region.

Ağvanis metamorphic rocks are bounded to the north and south by steeply dipping faults of the North Anatolian Fault Zone (Seymen, 1975); in the east and west the metamorphic rocks dip under young cover. The active fault in the south separates Ağvanis metamorphic rocks from the Suşehri basin of 1000-1200 meters altitude filled with Pliocene sediments. The large villages of the studied region (e.g. Kındık, Dikköy, Ağvanis. etc.) are located along this active fault. The fault, which limits the metamorphic rocks to the north, follows the valley of the Kelkit river, which is at an altitude of 900-1000 meters in this region. This steeply northward dipping fault forms the contact between the metamorphic rocks and Hacıören (Lias) and Taşdemir (Paleocene) formations (Fig. 2). Ağvanis metamorphic rocks situated between these two major faults form a flat plateau of 2000-2100 meters high with steep scarps along its northern boundary. This NW-SE trending plateau is divided into two by the N-S flowing Seme stream; which forms a deep gorge.

STRATIGRAPHY

The major rock units in the studied area are Ağvanis metamorphic rocks, Hacıören (Lias), Taşdemir (Paleocene) and Mendemebaşı (Eocene) formations, Neogene sediments and the parautochthonous Boynuktepe Group.

Ağvanis Group

Ağvanis Group consists largely of metabasites (% 60-70) with lesser amounts of metadacite, marble, calcschist and phyllite. Apart from these rock types Ağvanis Group includes acidic magmatic rocks, some of which are metamorphosed and deformed.

Ağvanis Group is best exposed in the deep valleys of Degirmendere and Dolaydere (Fig. 2). The approximately 4.5 km thick section of the Ağvanis Group, observed along these two stream sections, is shown in Fig. 3. Marble and calcschist horizons occur throughout the sequence interbedded with the more voluminous metabasites. The Ağvanis sequence can be roughly divided into three parts: at the base there are black metabasites locally showing pillow structures and grey to pink metadacites. Above comes a green, bluish-green, gray and locally graphitic phyllite horizon with thick marble and metabasite intercalations. The two kilometers thick uppermost part of the Ağvanis section, which can be observed uninterruptedly along Degirmendere, is dominated by dark green, bluish-green metabasite and metatuff with interbedded metadacite, marble, black calcschist and graphitic schist.

Apart from these rock types, which make up the bulk of the Ağvanis Group, metaserpentinite is observed in only one locality. It occurs in Çeki stream as a 50 m long and 20 m thick lens surrounded by metabasites. It occurs in the uppermost part of the Ağvanis sequence. The metaserpentinite has undergone regional metamorphism along with the basic volcanic rocks and consists of chrysotile and opaque.

The lithologies of the Ağvanis Group are described under three headings: a) metabasic, b) metasedimentary and c) metaacidic rocks. The acidic magmatic rocks, which also occur in other formations, are described separately.

Metabasic rocks. — Metabasic rocks, which make up the bulk of the Ağvanis Group comprise basalt, dolerite, tuff and pillow lava all metamorphosed in greenschist facies. In the field three types can be distinguished: metalava, metatuff and banded, black metabasite.

Metalava: Metalavas are light or dark bluish-green, dark green, hard, homogeneous, locally quartz-veined rocks; primary features are mostly obliterated and they posses a metamorphic fabric. There are rare massive dolerites which partly retain the primary magmatic textures and mineralogies; in these rocks the greenish-brown magmatic hornblendes are rimmed by pale green or bluish-green actinolites. Albite, epidote, chlorite, green or bluish-green actinolite are the major minerals in the metalavas. Most metalavas also contain minor amounts of quartz, calcite, phengite, opaque, sphene and biotite. Rotated poikilitic albite porphyroblasts up to one milimeter in diameter are surrounded by chlorite, epidote, actinolite and phengite. Epidote, actinolite and sphene occur as inclusions in albite porphyroblasts.

Metalavas are frequently interbedded with marbles and green phyllites of variable thickness (5 cm to 20 m); locally they can be seen to include marble fragments and to intrude between the marble layers. Such features indicate that the metalavas represent very shallow sills or lava flows and that they have a primary sedimentary rather than tectonic relationship to the marbles.

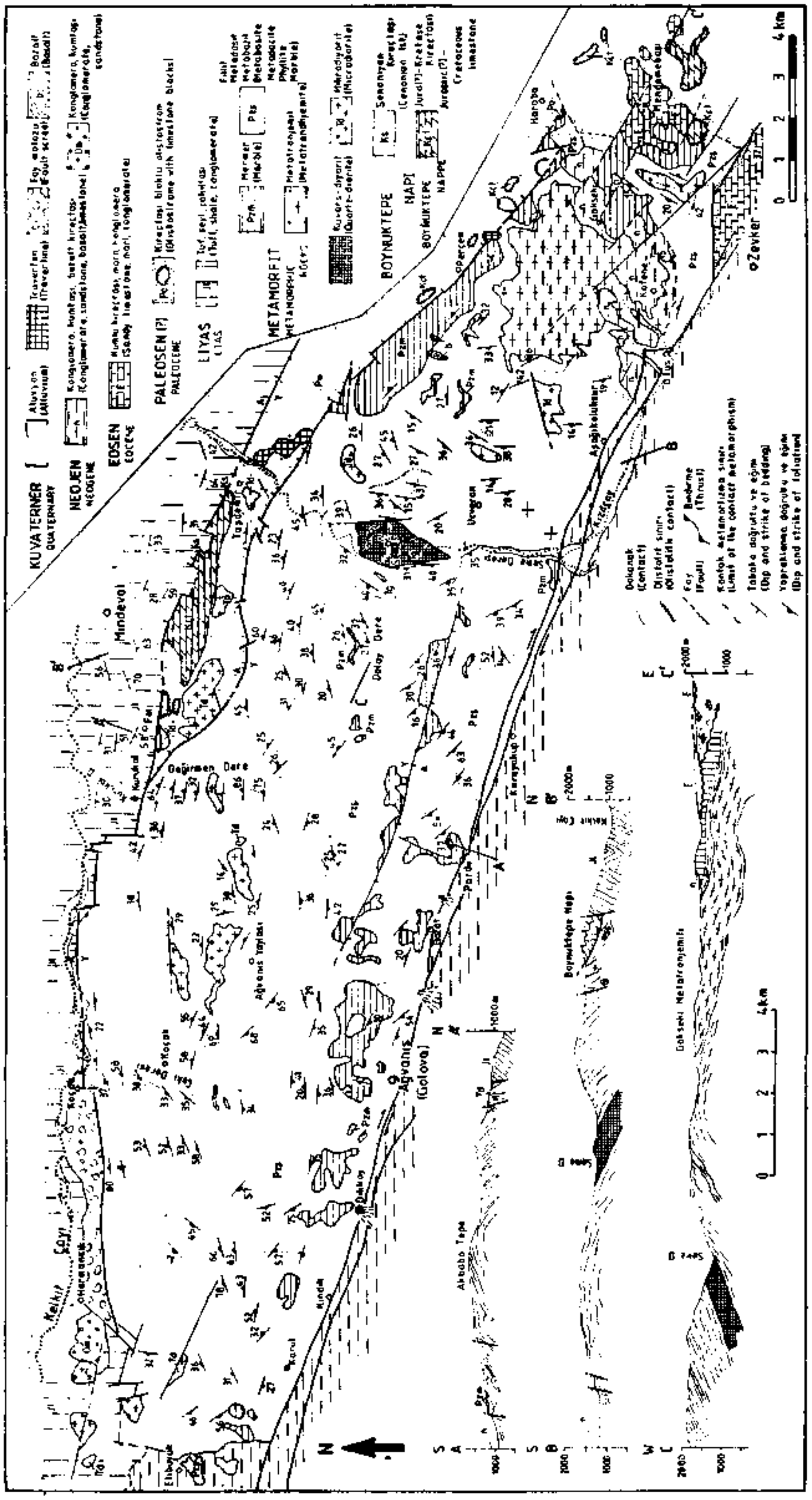

Fig. 2 - Geological map of the Ağvanis metamorphic rocks and neighbouring formations.

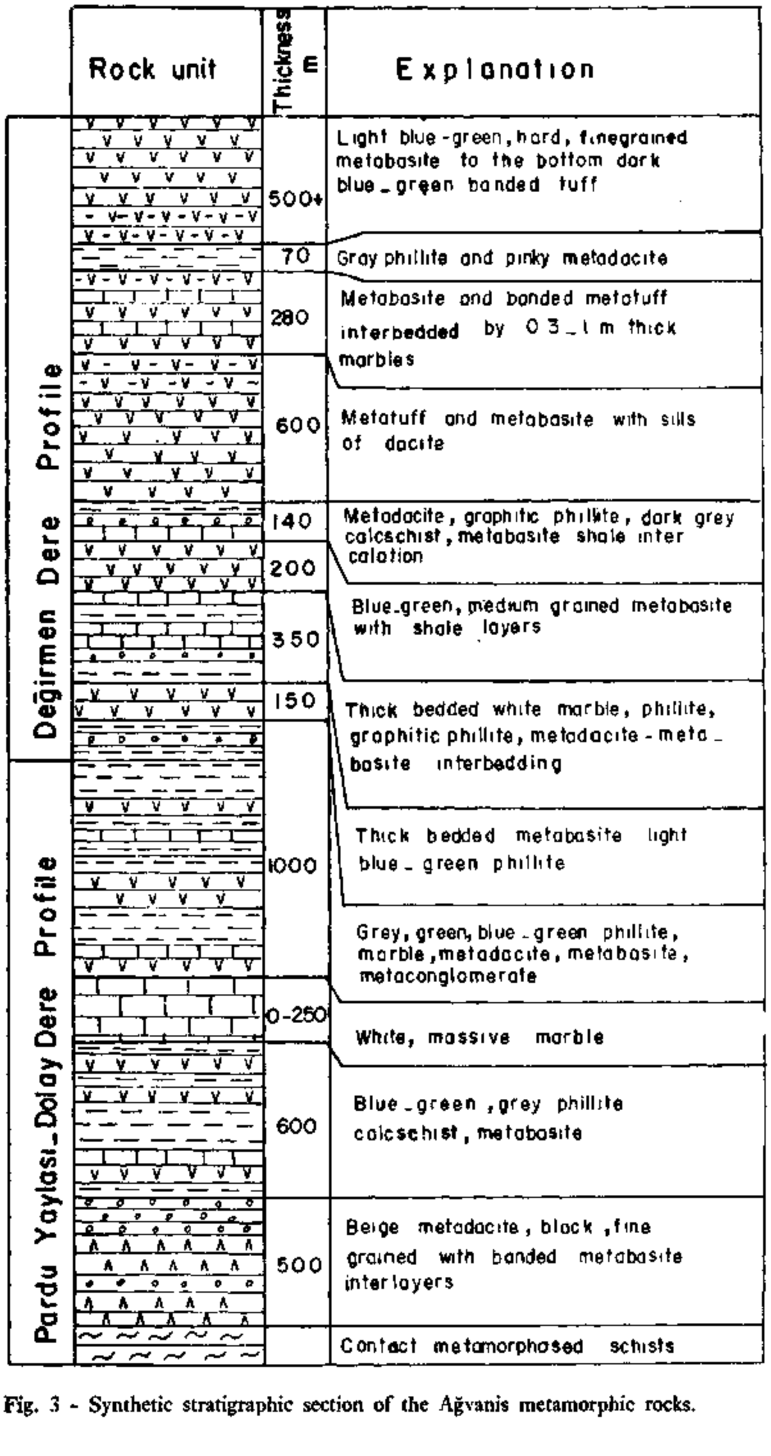

Fig. 3 - Synthetic stratigraphic section of the Ağvanis metamorphic rocks.

Metatuff: Metatuffs are laminated, fine-grained, pale yellowish-green bluish green rocks. Lamination, which is the distinguishing feature ofthe metatuffs, is marked by the alternation of approximately five milimeters thick yellow (epidote-rich) and pale green (chlorite-rich) bands. Lenses to epidosites, 20-30 cm large and consisting virtually wholly of epidote, occur within the metatuffs. Metatuffs, like the metalavas, are frequently interbedded with white marble bands of various thickness (lcm-5m). Metatuffs consist mainly of epidote, chlorite, albite, quartz and calcite; small amounts of opaque, sphene, biotite, phengite and bluish-green actinolite occur in some metatuffs. Albite blastesis, a characteristic petrographic feature of the metalavas, is not found in metatuffs.

Black metabasite: Black, banded metabasite, which is found in the lower parts of the Ağvanis sequence, is distinguished in the field by its conspicuous black colour and by banding. It forms fine grained, hard, irregularly black and yellow-black banded rocks with local epidosite lenses. In regions of relatively low deformation (e.g. one kilometer south of the Usveran village) pillow structures can be recognised within the black metabasites. Such observations suggest that black metabasites were originally thick pillow lava horizons and their present banded appearance is due to deformation and metamorphism. Thin (3-4cm) marble lenses within the black metabasites probably represent within lava sediments. Similar banded metabasites of pillow lava origin are described from the Austrian Alps (Holland and Norris, 1979). Black metabasites consist mainly of strongly parallel aligned bluish-green actinolite, epidote and albite; several specimens also contain small amounts of chlorite, sphene, opaque and biotite. Abundant magnetite imparts a black colour to the rock. Black metabasites are the dominant lithology east of Seme stream; they do not occur in other parts of the Ağvanis Group.

Metasedimentary rocks. — White marble is the next most abundant rock type after metavolcanics. It occurs throughout the sequence as thickly bedded (up to 4-5 meters) compact horizons, usually no more than 50 meters in total thickness. Only the total thickness of the marbles in the east of Seme stream, where they form the uppermost part of the sequence, is over 250 meters. Black marble and calcschist forms laminated, thin (1-2 meters) horizons. They include graphite and white mica in addition to calcite. Phyllites occur as fine grained, soft, micaceous, well foliated, bluish green, green, grey rocks. Locally they have a dark grey colour due to their high graphite content. There are also rare iron and manganese rich rocks. They are massive, banded, black rocks and consist of quartz, opaque, spessartine garnet and stilpnomelane.

Metaacidic rocks. — Metaacidic rocks of the Ağvanis Group must have originally formed lava flows, sills, and small or medium sized plutons. They show a distinctive metamorphic fabric and are generally concordant with the surrounding metamorphic rocks.

Metadacite: Dacites must have intruded the basic volcanic rocks of the Ağvanis Group before or during the regional metamorphism. Some metadacites have clear cross-cutting relations with the metamorphic rocks but are also folded and exhibit a metamorphic texture in the thin section (e.g. two kilometers south of the Kurukol village in the Değirmendere). However, other metadacites, which are intercalated with the metabasic rocks, may represent contemporaneous andesite and dacite flows.

Metadacites form compact, massive grey or dark grey rocks. In the handspecimen the metamorphic fabric is defined by up to one centimeter large, parallel aligned plagioclase phenocrysts. Plagioclase phenocrysts are rotated in the direction of the schistosity but still retain their primary magmatic features; they are set on a recrystallised groundmass of quartz and feldspar. The rarer quartz, and biotite phenocrysts are recrystallised to fine grained aggregates and are elongated parallel to the schistosity. Cataclastic texture is dominant in some metadacites: plagioclase phenocrysts are fractured and faulted on a microscopic scale. In some metadacites the primary magmatic texture is completely obliterated and the rock has transformed into a medium grained quartz-micaschist of quartz, plagioclase, chlorite and phengite; only the plagioclase phenocrysts, which partly retain their original size and habit, give away the original character of the rock. In addition to the regional metamorphism, metadacites are also affected by the contact metamorphism around the quartz-diorite pluton.

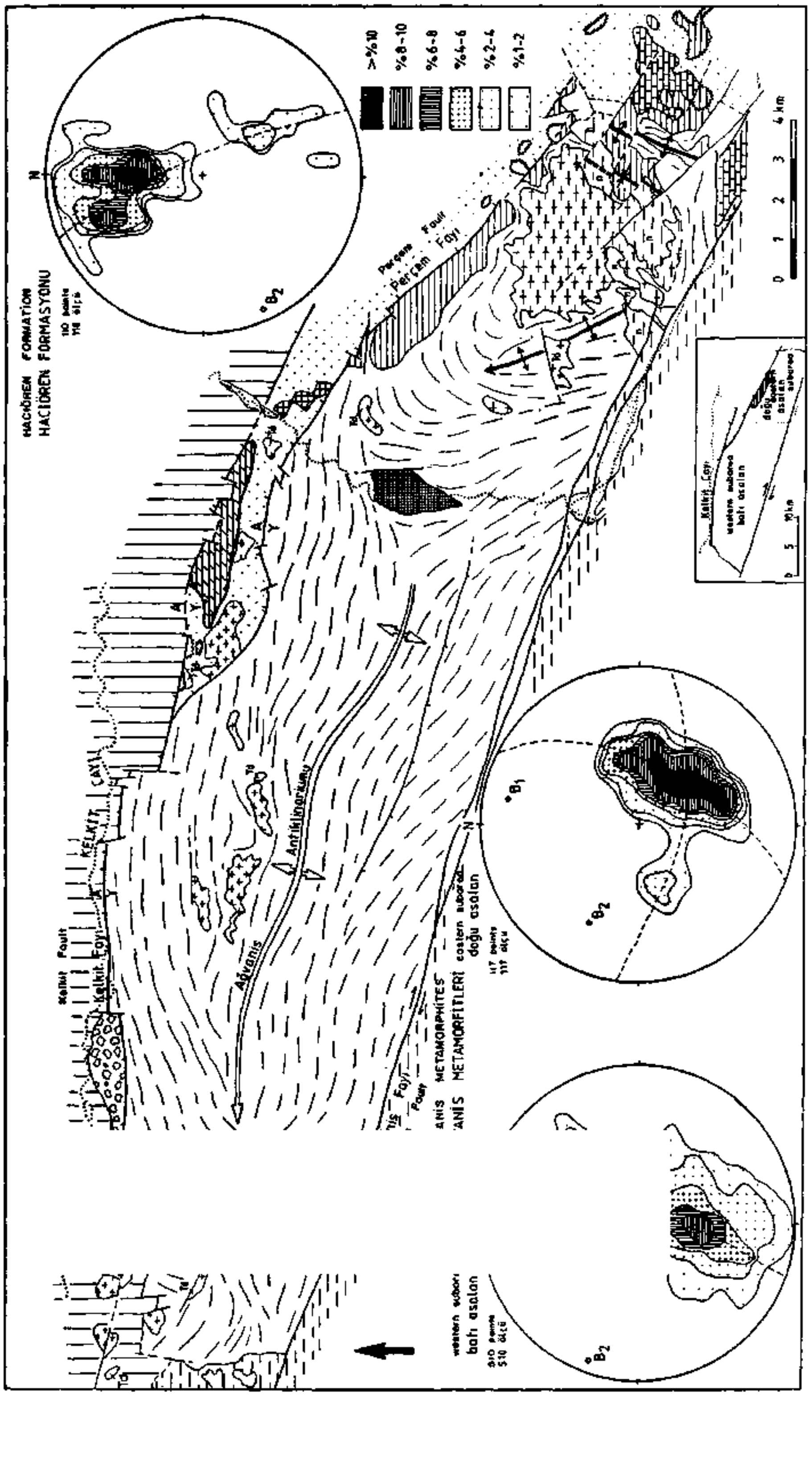

Fig. 4 - The structural map of the Ağvanis metamorphic rocks and Haciören Formation. The strike and dip of schistosity in two subareas in the Ağvanis Group, and the strike and dip of bedding in the Haciören Formation are shown in Schmidt nets. B_1 represents a possible pre-Alpine fold axis, while B_2 is the Alpine fold axes. The legend is the same as in Fig. 2.

Gökseki metatrondhjemite: A metatrondhjemite (IUGS classification, 1973) showing deformation and low-grade metamorphism occurs over a large area in the eastern part of the Ağvanis Group between the villages of Ofus and Per9em (Fig. 2). This plutonic intrusion, called as the Gökseki metatrondhjemite, has a form of a 500 to 700 meters thick sheet. It is conformable with the foliation in the surrounding schists and dips at a low angle (15-25°) to the north and east. After the intrusion it has been folded into N-S trending open synforms and antiforms (Fig. 4).

In the handspecimen Gökseki metatrondhjemite is a medium grained leucocratic rock consisting mainly of quartz and feldspar with very small amounts of mafic minerals. It shows a distinctive metamorphic fabric defined by the parallel aligned quartz and feldspar grains and locally resembles a leucocratic gneiss. The major minerals in the metatrondhjemite are plagioclase (50-60 %), quartz (40-50 %) and biotite ($<10\%$). Plagioclase forms euhedral, slightly zoned crystalls up to one milimeter long, which are aligned parallel to the regional schistosity. They are partially carbonitised and sericitised. Quartz, which is completely recrystallised, occurs as aggregates of variable grain size (0.01 mm-0.5 mm) showing undulose extinction. Quartz aggregates, which fill the spaces between the plagioclase crystals, show a distinct metamorphic lineation. Partially chloritised, dark brown biotite crystals 1-1.5 mm long are aligned parallel to the schistosity. The accessory minerals of the metatrondhjemite are opaque and apatite.

Gökseki metatrondhjemite is underlain by black metabasite and is overlain by a sequence of phyllite, marble, calcschist and metabasite. Although there is no contact metamorphic aureole around the Gökseki metatrondhjemite, a garnet-epidot skarn collected near the contact, 2.5 km north of Ofus village, suggests that the metatrondhjemite has intruded the country rocks before the regional metamorphism.

Contacts, age and environment of deposition. — The base of the Ağvanis Group is not exposed; the metamorphic rocks are unconformably overlain by Eocene sandstones. Similarly the contact between the Taşdemir Formation of Paleocene age and the metamorphic rocks is a plane of unconformity. Nebert (1961) erroneously maintained that Liassic conglomerates unconformably cover the metamorphic rocks around the village of Per9em at the northern boundary of the metamorphic rocks. However, rocks outcropping around Percem are an olistostrom of Paleocene age (Taşdemir Formation), and its contact with the metamorphic rocks in this region is faulted (Fig. 2). Further west the contact between the metamorphic rocks and Hacıören Formation of Liassic age is the major Kelkit Fault (Fig. 2). The age of deposition and metamorphism of the Ağvanis Group is pre-Eocene. The intrusion of the metadacite sills and Gökseki. metatrondhjemite must predate the regional metamorphism.

Ağvanis Group represents an environment dominated by basic volcanism; elastics derived from a continental source are very scarce. The frequent intercalation of metabasites with graphitic phyllites and thickly bedded marbles suggests that the environment of deposition was not very deep; pelagic intercalations are not observed in the Ağvanis sequence. Laterally continuous, regular marble horizons and absence of marble olistoliths in the sequence indicate that limestone deposition and basic volcanism were broadly contemporeneous. These features and the presence of a strong pre-metamorphic calc-alkaline acidic magmatism indicate an island arc setting for the Ağvanis Group. The Jurassic-Cretaceous sequence of the Eastern Outer Pontides consisting of basic volcanic rock-limestone intercalations (Zankl, 1961; Schultze-Westrum, 1961, 1962) closely resembles the sequence of the Ağvanis Group in terms of stratigraphy; lithological features and probably environment of deposition. The thick basic volcanic rock - limestone sequence of the Eastern Pontides, representing a Mesozoic island arc, is affected, like the Ağvanis Group by a strong and persistent calc-alkaline volcanism.

Metamorphic rocks of the Tokat Massif (Blumenthal, 1950) cover large areas between Amasya and Tokat 100 kilometers west of the Ağvanis Group. Reconnaissance studies in the Tokat Massif and descriptions of Tokat Massif (Blumenthal, 1950; Alp, 1972; Seymen, 1975; Koçyiğit, 1979; Özcan et al., 1980) indicate that the metamorphic rocks of both areas are similar in terms of lithology, stratigraphy and metamorphism. The only major difference between these two major rock complexes is the presence of acidic and metaacidic rocks in the Ağvanis Group. With the exception of a small area of metadacites south of Amasya (Alp, 1972), sych rocks have not been described from the Tokat Massif. The abundance of acidic magmatic rocks in the Ağvanis Group may be due to its proximity to the Eastern Pontide acidic magmatic province. Rocks very similar to the Ağvanis Group occur in tectonic contact with ophiolites between Suşehri and Erzincan (Nebert, 1961; Tatar, 1975; Bektaş, 1981; Ali Yılmaz 1982, personal communication).

Permian (Blumenthal, 1950; Koçyiğit, 1979) and Triassic (Özcan et al., 1980) fossils are recorded from the partially recrystallised limestones of the Tokat Massif. At several localities Liassic conglmoerates and sandstones are transgressive over the metamorphic rocks of the Tokat Massif (Blumenthal, 1950; Alp, 1972; Özcan et al., 1980). Thus the age of deposition of the rocks of the Tokat Massif and probably that of the Ağvanis Group extends up to the Triassic and the age of metamorphism is also Triassic. If the correlation between the Tokat Massif and the Ağvanis Group is correct, then the Ağvanis Group forms the metamorphic basement to the Hacıören Formation of Liassic age.

Hacıören Formation

Hacıören Formation, which consists of tuff, shale, volcanoclastic sandstone and basic volcanic rock, is described and named by Pelin (1977). It covers large areas to the north of the Ağvanis Group. The best exposures are around Mindeval and along the small streams flowing north from the metamorphic rocks into the Kelkit River (Fig. 2).

In the present study only a part of the sequence of the Hacıören Formation, lying within 3-4 kilometers to the north of the metamorphic rocks is mapped. In this area the sequence starts with massive, dark grey, purple and black volcanic rocks. They are followed by well bedded, flysch type sequence of volcanoclastic sandstone/tuff-shale; the thickness of this sequence is over 700 meters. The tuffs form compact, well bedded, dark grey, greenish grey, black rocks with bed thicknesses ranging from 10 to 40 centimeters. Dark grey, black shales occur between the tuff beds. Sedimentary structures - grading, cross-bedding, flow and slump structures - are common in the tuffs. Such sedimentary structures indicate that the beds are right way up and that they young southward. There are also rare, thin (< 50cm) coal horizons within the tuff-shale sequence (e.g. in the Fol stream, one kilometer north of the Fol village). Calcification is widespread in the tuffs; the calcified horizons are easily distinguished in the field from unaltered tuffs by their white or pale grey colour.

In the upper parts of the tuff-shale sequence there are coarse volcanoclastic sandstone and conglomerate horizons up to one meter in thickness. This coarse clastic horizons show conspicious grading and comprise volcanic rock, quartz and shale fragments up to 10 cm large. These sandstone-conglomerate beds, which increase in frequency up the sequence represent the youngest part of the Hacıören Formation in the studied area. An andesite horizon of a few meters thickness separates the tuff-shale sequence from the sandstone-conglomerate sequence.

The tuffs consist of fine grained and glassy basalt, plagioclase, quartz and dolerite fragments in a chloritic matrix. Carbonitisation is present in all the petrographically examined tuffs to various degrees. Plagioclase crystals are partially to totally replaced by calcite. In some rocks calcite makes up 80-90 % of the mode.

The base of the Hacıören Formation is not observed in the studied region. North of the Kelkit River, sandy limestones of Dogger to Lower Cretaceous age called Berdiga Formation by Pelin (1977) lie conformably over the Hacıören Formation. In the studied area terrigenous conglomerates of robable Oligomiocene age unconformably overlie the Hacıören Formation in the vicinity of Harmancık village. Hacıören Formation is in tectonic contact with the Ağvanis metamorphic rocks along the steeply dipping Kelkit Fault (Fig. 2).

Hacıören Formation is poorly fossilifereous. All the age data on the Hacıören Formation stems from the palinological study of the coal horizons within the formation. Such studies indicate a Liassic age for the Hacıören Formation (Ağralı et al., 1966; Pelin, 1977).

Clastic rocks of Liassic age comprising sandstone, shale, tuff, conglomerate and coal are widespread in the Eastern Pontides. Liassic rocks around Bayburt (Ketin, 1951), Reşadiye (Seymen, 1975) and Amasya (Alp, 1972) are very similar to the Hacıören Formation.

Boynuktepe Group

The newly defined parautochthonous Boynuktepe Group occurs to the north of the Ağvanis metamorphic rocks as a nappe overlying the Taşdemir Formation. It consists of carbonates and forms a 4.5 to 5 km long and 500-700 meters wide E-W trending ridge. The name of the Group is after the highest peak in this ridge. The type section is not measured; the reference section is 1.5 km to the east of Boynuktepe between Sivritaş Tepe and Gürlekbaba cemetary. The lower parts of the Boynuktepe Group consist of grey, thickly bedded to massive, locally fossiliferous neritic limestones. These neritic limestones are overlain around the Gürlekbaba cemetary and north of the Taşdemir village by thinly bedded red pelagic limestones with globotruncana (Fig. 2).

Boynuktepe Group tectonically overlies an olistostrome of Paleocene age (Taşdemir Formation); the tectonic contact between the two units is subhorizontal. In the north the subvertical Kelkit Fault makes the contact between the Boynuktepe Group and Hacıören Formation.

The thickness of the grey neritic limestones of the Boynuktepe Group is over 200 meters; the overlying red pelagic limestones are 40 to 50 meters thick. The microfossils in the red pelagic limestones from the north of the Taşdemir village *Globotruncana gr. lapparenti* Bolli, *Globotruncana* sp. *hedbergella, Hedbergella* sp., *Heterohelix* sp., *Cleterohelix* sp. (determination, D. Altıner, 1982) indicate a Santonian to Lower Maastrichtian age.

Boynuktepe Group is similar in lithology, stratigraphy and age to the Middle Jurassic - Upper Cretaceous carbonates, which are conformable over the Liassic Hacıören Formation north of Kelkit River. The grey neritic limestones from the lower parts of the Boynuktepe Group can be correlated with the Middle Jurassic - Lower Cretaceous Berdiga Formation described by Pelin (1977). The red pelagic limestones in the upper parts of the Boynuktepe Group are a very distinctive horizon in the Pontide Mesozoic sequence (cf. Pelin et al., 1982) and can be correlated with the Elmalı Dere Formation of Campanian age described by Pelin (1977). Such considerations indicate that Bovnuktepe Group is most probable Middle Jurassic to Upper Cretaceous in age.

Boynuktepe Group can be correlated, in terms of lithology, stratigraphy and age with the parautochthonous limestones named as the Çimen Dağı Nappe by Bergougnan (1975). Çimen Dağı Nappe covers large areas to the northeast of Erzincan and Boynuktepe Group probably constitutes the westernmost extension of the Çimen Dağı Nappe.

Taşdemir Formation

The newly described Taşdemir Formation is an olistostrome, which occurs to the north and east of the Ağvanis Group. The name of the formation is from the Taşdemir village, where the best exposures are. The reference section passes from the south and west of the Taşdemir village; a type section is not given, as the formation is not studied in detail. Taşdemir Formation is bounded to the north and south by subvertical faults and outcrops in a narrow and elongate, zone (Fig. 2). It consists of yellowish-brown, reddish, massive sandstones and grits comprising grey fossiliferous limestone block, and fragments ranging in size from a few centimeters to a few hundred meters. There are also rare thin coal horizons in the sandstones (for example, in the Hülerin creek, one kilometer to the south of the Taşdemir village).

Large limestone olistoliths from a few meters to a few hundred meters are concentrated in the eastern part of the studied area. These olistoliths are surrounded by grits and debris flows with smaller limestone fragments. Transition from limestone olistoliths to limestone debris flows can be observed in the field (for example 2 km southeast of Perçem village around the Gökseki Yaylası). Debris flows with limestone fragments ranging in size from two to ten centimeters are very common; the fragments are densely packed and commonly rounded. 80-90 % of the fragments consist of grey limestone, the rest are phyllite and spilite.

Sandstones of the Taşdemir Formation lie over the marbles of the Ağvanis Group southwest of the Haraba village in the eastern part of the studied area; however, the nature of the contact is not very clear. Mendemebaşı Formation of Eocene age lies unconformably over the Taşdemir Formation around the Mendemebasi village. West of Seme stream, the parautochthonous Boynuktepe Group lies tectonically over the Taşdemir Formation (Fig. 2).

As the bedding is not well developed, it is difficult to estimate the thickness of the Taşdemir Formation; it has a probable minimum thickness of 100-150 meters. A limestone block from the Taşdemir Formation collected 2.5 km west of Kötüköy has the following microfossils (determination D. Altıner, 1982) *Montoharmontia* cf. *appeninica compressa* (De Castro), *Minuoxia* cf. *conica* Gendrot, *Dicyclina* sp., *Snlcoperculina* sp., *Rotalia* sp. and indicates a Santonian or probable Campanian age. Another limestone block collected 750 meters north of Percem village has the microfauna (determination D. Altıner, 1982) of *Mayneine?, Textitlariidae, Vernuilinidae a'sipkon, Valrulhia* sp., *Ophthalmidium* sp. which indicates a probable Lower Cretaceous age.

Outside the studied area in the north, Taşdemir Formation lies unconformably over the Maastrichtian flysch (A. Yılmaz, 1982 personal communication) and in the studied area it is overlain by Eocene sediments. Thus the age of deposition of the Taşdemir Formation is probably Paleocene.

Taşdemir Formation is tectonically overlain by the Boynuktepe Group of Jurassic-Cretaceous limestones. The debris and olistoliths in the Taşdemir Formation are very similar to the lithologies of the Boynuktepe Group and are most probable derived from the Boynuktepe Group. Taşdemir Formation must have been deposited as an olistostrome in a shallow but subsiding basin created in front of the advancing Boynuktepe Nappe.

Taşdemir Formation closely resembles and can be correlated with the «Işkilör Olistostrome» described by Bergougnan (1975) from the north of Erzincan. Işkilör olistostrome of Late Paleocene age, lies like the Taşdemir Formation, underneath a large carbonate nappe (Bergougnan, 1975).

Mendemebaşı Formation

Mendemebaşı Formation, which occurs in the eastern part of the studied area and lies unconformably over the Ağvanis metamorphic rocks and Taşdemir Formation, consists of Eocene sandstones and is mapped and described for the first time. The name of the formation is from the Mendemebaşı village around which the best exposures are. The type section is not measured; the reference section is between the Mendemebaşı village and Taşdemir Formation. Mendemebaşı Formation consists of yellowish-brown, locally conglomeratic and plant-bearing, cross-bedded compact sandstones. These sandstones comprise locally abundant nummulites. In the absence of paleontological determinations, the formation can be said to be broadly of Eocene age. The beds in the Mendemebaşı Formation are subhorizontal. Although its contact with the Ağvanis metamorphic rocks and Taşdemir Formation is not well exposed, the fact that it covers both units (Fig. 2) indicates an unconformity. The maximum thickness of the Mendemebaşı Formation is about 100 meters in the vicinity of the Mendemebaşı village.

Eocene mudstones, sandstones and conglomerates of a somewhat different lithology are found southeast of the studied area around the village of Zevker (Fig. 2). The sandstones are grey, well-bedded and comprise plant and wood fragments, and nummulite, gastropod and lamellibranch fossils. Quartz-conglomerates and grey mudstones are interbedded with the sandstones.

Neogene deposits

A red conglomerate of 50-60 m thickness comprising well rounded serpantinite, spilite, schist and limestone boulders of various sizes lies unconformably on the Hacıören Formation around the Harmancık village northeast of the studied area (Fig. 2). No fossils have been found in this terrigenous deposit, which has a large outcrop area around Şebinkarahisar. On the 1:500 000 scale geological map it is shown to be of Oligomiocene age (Göksü, 1962).

Suşehri plain, which lies to the south of the Ağvanis metamorphic rocks, is underlain by sand, clay, poorly consolidated sandstone and conglomerate of probable Pliocene age (Nebert, 1961). In the eastern part of the studied area Ağvanis metamorphic rocks are overlain by quartz-conglomerate, poorly consolidated, lamellibranch and gastropod bearing marl and limestones probable again of Pliocene age.

Purple andesite and andesite debris is closely associated with Pliocene sediments southwest ot the village of Ofus. Two olivine basalt flows occur in the metamorphic rocks west of Perçem village. Well preserved vesicles and cooling joints indicate that the basalts are recent and have flowed on the present topography.

ACIDIC MAGMATISM

A strong acidic magmatism has affected Ağvanis Group and the surrounding rocks. The acidic magmatic rocks are found as sills, and small to medium sized plutons.

Dacite

Hundreds of pale grey to pink dacite sills occur in the Ağvanis Group; sills are-not encountered in the surrounding rocks. The thickness of the sills ranges from ten centimeters to ten meters with an average thickness of one meter. They have no lateral continuity and cannot be followed for more than hundred meters. Although they generally follow the schistosity in the metamorphic rocks, they have been locally observed cross cutting the metamorphic recks.

Dacites have a holocrystalline, porphyritic texture. The ubiqutous euhedral plagioclase phenocrysts (An_{38-42}) are one to three milimeters large and show strong cyclic zoning. Several dacites contain in addition to the plagioclase phenocrysts, subhedral, locally corroded quartz, brown biotite and partially chloritised hornblende phenocrysts of about one milimeter large. Phenocrysts, which make up 30-50 % of the rock lie on a fine-grained (<0.01mm) matrix consisting of feldspar, quartz, biotite and opaque. Alteration is common in the dacites; plagioclase phenocrysts and the matrix show serialization and carbonitization, hornblende and biotite grains are partially to totally replaced by chlorite.

Small plutons

Several stocks, 100 to 500 meters thick and about one kilometer long, occur within the Ağvanis Group and neighbouring rocks. These plutons can be divided into several types according to their modes of intrusion. Some of these are not a single intrusion but consists of hundreds of parallel and densely packed dacite sills, one to two meters thick. Such dacite sills do not show cross-cutting relations and thin (10-20 cm) schist horizons may.be present between the sills. The stock in the Değirmendere (Fig. 2) is a good example for such sill-complex type plutons.

A large number of plutons occur as massive porphyritic microdiorite sills. Metamorphic rocks are commonly found as xenoliths in such plutons. Three intrusions of this type occur around the Ağvanis Yaylası (Fig. 2). They show cataclastic, porphyritic and holocrystalline textures. One milimeter long plagioclase phenocrysts showing strong cyclic zoning and biotite phenocrysts, which are commonly recrystallised to finer grained aggregates, are set on a medium grained matrix of quartz, plagioclase, microcline, muscovite, biotite and opaque. There is also minor apatite, sphene and secondary epidote. Myrmekitic texture is present in some rocks.

The pluton north of Aşağıkölükser village (Fig. 2) is similar to the Seme quartz-diorite. It is coarse grained and has quartz, biotite and plagioclase as the major minerals. The small plutons in the Hacıören and Taşdemir Formations are massive porphyritic dacites with steep contacts with the country rock.

Seme quartz-diorite

This coarse grained quartz-diorite (IUGS classification, 1973) occupies an area of two square kilometers in the Seme valley. It is cut by dacite dykes and forms a 500 meters thick sheet, which dips at 30° to the west and pinches out to the north and south. The quartz-diorite has intruded into the core of the Ağvanis anticlinorium and has modified the structure in the surrounding rocks. The concordant contacts of the pluton with the schistosity in the metamorphic rocks is apparent from Fig. 4. The intrusive nature of the quartz-diorite is indicated by the schist xenoliths and the contact metamorphic aureole around the pluton.

In the handspecimen white plagioclase, black hornblende and smaller amounts of biotite and quartz are easly discernable by naked eye. Quartz-diorite mainly consists of plagioclase (60-70%), hornblende (15-20%), quartz (10-15%) and biotite (5-10%). Plagioclase forms 1-2 mm large, euhedral crystals, which show cyclic zoning. Recrystallised quartz and myrmekite consisting of an intergrowth of quartz and plagioclase occurs in the interstices of plagioclase grains. Dark green, bluish green hornblende, often showing twinning, forms 0.5-2 mm large prismatic crystals. 0.5 to 1 mm large brown biotite is partially chloritised. Accessory minerals include sphene, apatite and ilmenite, which is rimmed by sphene. Epidote and chlorite are secondary minerals.

The age of acidic magmatism

In the Eastern Pontidies acidic magmatism was active in two distinct periods. The most important intrusion of the older period is the Gümüşhane pluton of Permocarboniferous age (Çoğulu, 1970; Delaloye et al. 1972; Yılmaz, 1972). Gümüşhane pluton, which shows no metamorphism, is intruded into a metamorphic basement of pelitic and psammatic gneisses and micaschists (Yılmaz, 1972). Sedimentary rocks of Liassic age are unconformable over these metamorphic rocks and over the Gümüşhane pluton (Ketin, 1951). The plutons of Upper Jurassic to Tertiary age representing the younger period of acidic magmatism are widespread over a large area (Çoğulu, 1970; Taner, 1977; Gedikoğlu, 1978).

It is not clear whether the acidic and metaacidic magmatic rocks of the Ağvanis Group belong to a single or two periods of acidic magmatism. Lower Lutetian sediments with basal conglomerates are transgressive over a granite, which intrudes into the Hacıören Formation 15 km west of the studied region (Nebert, 1964). This suggests that acidic magmatic rocks in the Hacıören and Taşdemir formations, and post-metamorphic Seme quartz-diorite and dacite sills within the Ağvanis Group are Upper Paleocene-Lower Eocene in age. The intrusive ages of the Gökseki metatrondhjemite and metadacites are pre-metamorphic and probably Triassic or earlier. Nebert (1961) also suggests the existence of two periods of acidic magmatism in the Ağvanis Group. However, a strong mylonitisation and cataclasis have been described from the Alpine Harşit granit (Nebert, 1964) and it is also possible that part of the acidic magmatic rocks within the Ağvanis Group were deformed and acquired a cataclastic texture during the Alpine movements.

STRUCTURE

The structure ofthe region will be explained in four sections: (a) the structure of the Ağvanis metamorphic rocks; (b) the structure ofthe neighbouring rocks, especially the Hacıören Formation; (c) Nappe movements; (d) Recent faulting related to the North Anatolian Fault Zone.

The structure of the Ağvanis metamorphic rocks

Schistosity in the Ağvanis Group is well developed especially in the fine grained, micaceous phyllites. It is parallel to the bedding and is defined by the parallel alignment ofthe mica grains. Regional schistosity in the Ağvanis metamorphic rocks follow two directions. In the west the average strike of the schistosity is NW-SE (N60-80W) and dips at variable angles (10-60°) to the NE or SW, whereas in the east the strike of the schistosity is roughly N-S and the dips are generally to the west (Fig. 4).

Isoclinal and close folds are commonly observed in the laminated metatuffs and calcschists. Such folds are generally ofsmall scale (<30 cm) and have axial planer foliations; the fold axes dip with low angles to the west (6-12°). The absence of marker horizons in the metamorphic sequence makes it difficult to determine whether large scale isoclinal folds are present. A distinctive mineral lineation has not developed in the metamorphic rocks.

The western and eastern parts of the Ağvanis Group roughly separated by the Seme stream have different overall structures. A major, asymmetrical, ESE-WNW trending (N69W) and shallowly westerly dipping (8°) anticlinorium, named as the Ağvanis anticlinorium, characterises the structure in the western part of the Ağvanis Group (Fig. 4). The schistosity in the northern limb of the anticlinorium dips regularly and at high angles (50-70°) to the north. The dips of the schistosity in the southern limb of the Ağvanis anticlinorium ace gentler and more variable; although the dips are generally to the south, small scale, disharmonious and laterally discontinuous monoclinal folds are common. Such small monoclinal folds cause the direction and amount of the dips to change over short distances, and results- in the boudinage of the massive marble horizons, which are intercalated with less competent schists. The isolated marble outcrops in the south of the Ağvanis Group (Fig. 2) have formed by such a process, and the variable and gentle dips of the schistosity in this region have resulted in a large outcrop area for the marbles quite unproportionate to their thickness in the sequence.

In the eastern part of the Ağvanis Group there are N-S trending and northward dipping antiforms and synforms. They can be best observed in the Gökseki metatrondhjemite and overlying marbles (Fig. 4). This open antiforms and synforms gradually fade towards the north. The strike of the schistosity in the eastern part of the Ağvanis Group is roughly N-S parallel to the trend of the antiforms and synforms.

This difference in the structure between the eastern and western parts of the Ağvanis Group can be explained in two separate ways: (1) Modification of the original structure by the post-metamorphic acidic intrusions; (2) The presence of separate phases of deformation.

The post-metamorphic acidic intrusions had a major effect on the structure of the Ağvanis metamorphic rocks. This modification of the original structure can best be observed around the Seme quartz-diorite (Fig. 4). The schistosity in the metamorphic rocks rotates around the quartz-diorite, which has intruded into the core of the Ağvanis anticlinorium (Fig. 4). The strike of the schistosity, which was originally E-W, rotates around the pluton to NNE-SSW and to NNW-SSE directions. (Fig. 4). With increasing distance from the pluton, the strike of the schistosity returns to the original E-W direction. Rotation of the schistosity around the plutons can also be observed around the smaller intrusions in the Ağvanis Yaylası. The rotation of bedding or schistosity around the plutons into conformity with the contacts of the pluton is described at several places; two examples are the White Creek batholith in the British Colombia, Canada (Reesor, 1958) and Pikes Peak batholith in Colorado, USA (Hutchison, 1960).

However, the N-S trending antiforms and synforms in the eastern part of the Ağvanis Group cannot be explained by the effects of the intrusion of the quartz-diorite, as the distances involved are too great. In this case the presence of two deformation phases is more probable. In the studied region there must be structures related to two different orogenies. One of this is of Triassic age and have resulted in the metamorphism and deformation of the Ağvanis Group; the other is the Alpine orogeny, which has affected all of the pre-Eocene rocks and caused nappe movements. As there is no major competence difference between the elastics of the Hacıören Formation and Ağvanis Group (Pelin, 1977), the metamorphic basement (Ağvanis Group) must have been folded with its cover (Hacıören Formation) during the Alpine orogenesis. In other words «decollement» tectonics did not operate during the Alpine orogeny in this region. Thus Ağvanis metamorphic rocks must show evidence for Late Hercynian (Triassic) and Alpine orogenies. The fold axes in the Mesozoic sequence north of the Kelkit river are parallel to the axis of the Ağvanis anticlinorium and trend roughly E-W and dip at low angles (4-10°) to the west (Pelin, 1977). This suggests that the Ağvanis anticlinorium is of Alpine, whereas the N-S trending antiform and synforms are of Late Hercynian age. In fact, as expected Gökseki metatrondhjemite, which is more massive and competent than the other metamorphic rocks, preserves the traces of the older orogeny in its N-S trending fold axes. Seymen (1975), who worked in the metamorphic rocks around Reşadiye, indicates that in these metamorphic rocks, which are very similar to the Ağvanis Group, the development of N-S trending folds were followed by the E-W trending folds.

The structure of the sedimentary rocks

The strike of the bedding in the Hacıören Formation is roughly E-W and the dips are generally to the south (Fig. 4). Chevron type, generally symmetrical, upstanding, overturned and recumbent folds of large amplitude (>40 m) are frequently observed in the Hacıören Formation (for example, 1.5 km south of Mindeval in the Hoyran Dere valley). The plunge of the fold axes is variable and the fold axial planes generally dip to the south.

The bedding has not well developed in the olistostromes of the Taşdemir Formation and its internal structure is difficult to ascertain. The beds of the Mendemebaşı Formation of Eocene age are subhorizontal and no major folding is observed in this formation.

Nappe movements

In the studied region Boynuktepe Group of Jurassic-Cretaceous age tectonically overlies Taşdemir Formation of Paleocene age. The subhorizontal nappe contact between the Boynuktepe limestones, which make up an imposing ridge and underlying sandstones and olistostromes of the Taşdemir Formation is conspicuous even from a large distance. Shearing and brecciation is not observed at the nappe contact. The presence of the nappe is established only through paleontology and stratigraphy.

Boynuktepe Group, which can be correlated with the Çimen Dağı Nappe of Bergougnan (1975), is a good example for the type of nappes, which move on the surface shedding detritus to the subsiding basin in front of it and then overriding its own detritus. Such nappes are common in the Taurides; for example Tekeli (1981) described an ophiolite nappe on top of a thick Mesozoic carbonate sequence in the Aladağ region; at the base of the ophiolite nappe there is a syntectonic olistostrome with abundant ophiolite detritus.

Nappes are not common in the Pontides. During the Cretaceous and Tertiary most of the nappe movements occurred in the Anatolides and Taurides. In this respect the region north of Erzincan is an exception. In this area an ophiolite nappe has been emplaced on the Pontide Mesozoic sequence during the Late Cretaceous. This ophiolite nappe, called as the Karayaprak Nappe by Bergougnan (1975), can be seen just northeast of the studied area around the village of Karayaprak. Parautochthonous Çimen Dağı Nappe (equivalent to the Boynuktepe Group) lies with the basal olistostrome (Taşdemir Formation) on the Karayaprak Nappe and autochthonous Mesozoic sequence. These northward directed «retrocharriage» type nappe movements in the Pontides extend only 20-25 km north of the Erzincan-Refahiye ophiolite zone. Further north in the Alucra region only an angular discordance exists between the Maastrichtian-Paleocene volcanogenic flysch and Lower Lutetian sandy limestones (Pelin, 1977). There is no evidence for nappe movements during this time interval in this region.

Faulting related to the North Anatolian Fault Zone

Many of the faults in the Ağvanis metamorphic rocks and neighbouring formations are part of the North Anatolian Fault Zone. Apart from the major faults bounding the metamorphic rocks in the north and south, there are several smaller faults, which have affected the metamorphic rocks. The major movement along the North Anatolian Fault Zone is dextral strike-slip/Ketin, 1948); however, important vertical movements also exists along these faults.

Ağvanis Fault, which forms the southern boundary of the metamorphic rocks (Fig. 4), is still active (A. Koçyiğit, 1981, personal communication). The westward bending of the N-S trending small streams and ridges near the Ağvanis Fault indicates that the movement was mainly dextral the fault. However, through the vertical component of motion along the Ağvanis Fault, the northern block of metamorphic rocks was uplifted relative to the southern block, and small alluvial fans have formed in front of the small streams.

Kelkit Fault, which bounds the metamorphic rocks in the north (Fig. 4), forms a steep scarp. The fault plane dipping 70-80° to the north can be observed in a few places (for example, east of the Koçak village). In the west a debris deposit over 50 meters in thickness, derived from the uplifted metamorphic rocks, occurs immediately to the north of the Kelkit Fault (Fig. 4). Metamorphic rocks are considerably uplifted along the Kelkit Fault relative to the Hacıören Formation. By the present topography the vertical throw along the fault can be said to be a minimum of 200 meters. There is no geological or geomorphological evidence for lateral motion along the Kelkit Fault. Geomorphological data (M. Keçer, 1981, personal communication) indicate very recent vertical movements along the fault; drainage is very poorly developed in the Ağvanis Group especially in the northern hill sides overlooking the Kelkit River. Degirmendere, which is one of the few streams flowing through the metamorphic rocks northward into the Kelkit River, has a very steep sided «V» shaped valley while it is flowing in the metamorphic rocks. As soon as Degirmendere passes to the north of the Kelkit Fault into the Hacıören Formation, it forms a broad valley with a large and flat alluvial plane. The stream is eroding vertically in the recently uplifted southern block whereas in the more stable northern block it has reached a stable level with respect to the Kelkit River and is eroding laterally. Although Kelkit Fault has a very distinctive morphology it is not active and is displaced by small tear faults (Fig. 2).

Immediately to the east of the Kurukol village Perçem Fault branches off from the Kelkit Fault (Fig. 4). Perçem Fault, which separates metamorphic rocks from the Taşdemir Formation is topographically not distinctive. Along the fault the southern block of metamorphic rocks has been uplifted relative to the northern block. The Kelkit and Per9em Faults can be followed as distinct lines along the northern contact of the metamorphic rocks. However, they loose their singular character and branch off to several smaller faults in the east and west where the metamorphic rocks disappear under young cover (Fig. 4). This change in fault behaviour can be related to the loss of competence difference between the metamorphic and sedimentary rocks outside the outcrop limits of the Ağvanis Group.

Ağvanis metamorphic rocks form a horst bounded to the north and south by major faults. This horst topography of the metamorphic rocks is probably caused by the contemporeneous dextral movement along two subparallel faults (Kelkit and Ağvanis Faults) forming a pressure ridge.

METAMORPHISM

Regional Metamorphism

Ağvanis metamorphic rocks, covering an area of 280 km^2, do not show any change in metamorphic grade. Typical greenschist facies mineral paragenesis of «albite-chlorite-epidote-actinolite/barroisite-phengite» has developed in the ubiquitous metabasites. Biotite, which occurs locally in the metamorphic rocks, can be related to the effects of contact metamorphism around the acidic intrusions. The presence of bluish-green, sodium rich barroisite in the metabasites indicates that the pressure of metamorphism was slightly higher than in the «normal» greenschist facies (Shido and Miyashiro, 1959).

Contact Metamorphism

A contact metamorphic aureole of 500 meters thickness and 600 to 1500 meters width has developed around the Seme quartz-diorite. Large number of dacite dykes and sills occur in the contact metamorphic aureole. The effect of contact metamorphism is more marked at the base of the quartz-diorite in the eastern part of Seme stream. Phyllites and metadacites comprise abundant (30-40%) brown biotite in the contact metamorphic aureole. Plagioclase, which is normally of albite composition, shows increase in anorthite content and becomes labradorite, and coarse (l-2mm) andalusite develops in the contact aureole. Andalusite porphyroblasts, which are only found in the east of Seme stream, are partially to totally replaced by sericite. In the inner parts of the contact aureole the low grade regional metamorphic rocks are transformed into medium grained biotite micaschists. The highest grade paragenesis in quartz rich rocks in the contact metamorphic aureole is «quartz-biotite-muscovite-plagioclase-andalusite». This mineral paragenesis corresponds to the hornblende-hornfels facies of the contact metamorphism. The presence of andalusite and muscovite indicates that the temperatures during the contact metamorphism was 350-500°C (Turner, 1981).

The effects of contact metamorphism is less conspicuous in the metabasic rocks. Biotite is not abundant because of the unsuitable rock composition. With decreasing distance to the quartz-diorite, actinolite in metabasic rocks is replaced by hornblende, and hornblende by pale green diopside. The anorthite content of the plagioclase increases to labradorite. The highest grade paragenesis in the metabasites in the contact metamorphic aureole is «diopside-hornblende-plagioclase-biotite».

DISCUSSION

Ağvanis Group forms the easternmost extension of the Permotriassic metamorphic unit, which can be traced throughout the Inner Pontides, and is named as the Karakaya Formation by Bingöl et al. (1975). Karakaya Unit consists mainly of basic volcanic rocks with lesser amounts of limestone and elastics, and represents a Triassic orogeny, which has affected large areas in the Pontides. Middle Triassic to Liassic sediments are transgressive over this metamorphic unit, which forms the basement to the Mesozoic sequence of the Inner Pontides. Karakaya Unit is known in the west in the Biga peninsula as the Karakaya Formation (Bingöl et al., 1975), in the south of Biga peninsula as the Halilağa Group (Akyürek and Soysal, 1983), in the Söğüt and Bozöyük regions as Karasu (Yılmaz, 1977) and Bozöyük (Ayaroğlu, 1979) metamorphic rocks, in the Ankara region as Dikmen greywackes and Elmadağ Series (Erol, 1956) and between Tokat and Amasya as the Tokat Massif (Blumenthal, 1950). A progressive greenschist facies metamorphism is commonly observed in the Karakaya Unit. Yılmaz (1977) has described progressive metamorphism of basic volcanic rocks to garnet-amphibolites in the Söğüt region.

Bingöl et al. (1975), who initially drew the attention to the Karakaya Unit, regarded it as the deposits of a rifting event during Triassic. Tekeli (1981) considered it as a melange prism in a subduction zone. A different interpretation is that of Şengör and Yılmaz (1981), who regard Karakaya Unit as signifying an oceanic basin which came into existence and was terminated during the Triassic. However, the absence or scarcity of pelagic sediments and ultrabasic rocks in the Karakaya Unit, suggests that it does not represent a deep oceanic basin. Furthermore, no pre-Liassic nappes or thrusts are described in the Karakaya Unit, which would have been expected if it was related to the wholesale destruction of an oceanic basin. Probably it is misleading to ascribe a single environmental setting to the Karakaya Unit, which covers such a large area. Rather with its lithology and structure Karakaya Unit resembles the deposits of a rift, which has not reached the oceanic stage (back-arc basin?), and a volcanic island arc complex.

An unmetamorphosed thick Permocarboniferous sequence of arkose, quartzite, tuff, shale, limestone and andesite is described from the region of Bayburt (Ketin, 1951; Ağar, 1977). This Permocarboniferous sequence is most probably transgressive over the nearby high-grade pelitic and psammatic gneisses and schists in the Pulur Mountains. The upper parts of the Permocarboniferous sequence, showing rhythmic limestone-sandstone/tuff-shale intercalations (Ketin, 1951) are similar to the Ağvanis metamorphic rocks. It may be that with decreasing metamorphic grade Ağvanis metamorphic rocks pass laterally to the Pulur Permocarboniferous sequence. If this correlation is correct than at the base of the Karakaya Unit there is an older metamorphic basement of pelitic and psammatic gneisses and schists.

After the Triassic Karakaya orogeny, whose significance is still not clear, Lias has developed in the studied area, like in all the Inner Pontides, in clastic facies. North of the studied region there is a continuous sequence from Lias up to the Senonian (Nebert, 1961; Pelin, 1977). The Malm discordance observed in the Bayburt region (Ketin, 1951) is not present. The first indication of the Alpine orogeny starts with the Senonian discordance; in the Alucra region Senonian limestones are locally transgressive as for down as Liassic sandstones (Pelin, 1977). Further east ophiolite obduction occurs in this time interval (Ketin, 1951). After Senonian the region was dominated by N-S compression. In the latest Cretaceous ophiolite obduction occurs in the"north of Erzincan and Refahiye while flysch deposition continuous in the Alucra region. In the Paleocene, Çimen Dağı Nappe, which consists of carbonates representing the more pelagic and southerly facies of the Inner Pontide Mesozoic sequence, was thrust northward over the ophiolite and the autochthonous Pontide sequence. During the Eocene major thrusting is described from the region of Bayburt (Ketin, 1951) and south of Refahiye. N-S compression, which was dominant in the region since Senonian, finally ends in Miocene with the inception of the North Anatolian Fault Zone (Şengör, 1979).

RESULTS

The important results and conclusions of this study are:

— A 1:25 000 scale geological map of the Ağvanis metamorphic and neighbouring rocks has been prepared.

— The lithology, stratigraphy, structure and metamorphism of the Ağvanis metamorphic rocks have been studied and was concluded that the Ağvanis Group can be correlated with the rocks of the Tokat Massif, which were metamorphosed during Triassic. Ağvanis Group constitutes the metamorphic basement to the Liassic Hacıören Formation.

— Some of the acidic magmatic rocks within the Ağvanis Group have undergone deformation and metamorphism; the age of intrusion of these magmatic rocks is probably pre-Liassic. The rest of the acidic magmatic rocks are of Paleocene age and cut the metamorphic rocks.

— The contact of the Ağvanis metamorphic rocks with the Liassic Hacıören Formation is, contrary to previous information, tectonic.

— A nappe is described for the first time in the studied region. Boynuktepe Nappe, comprising Jurassic-Cretaceous limestones, tectonically overlies an olistostrome (Taşdemir Formation) of its own debris.

— Eocene and Oligomiocene (?) rocks are described for the first time in the studied region. Eocene sandstones are unconformable over the Ağvanis metamorphic rocks and Taşdemir Formation. Oligomiocene (?) terrigenous sediments lie unconformably over the Liassic Hacıören Formation.

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REFERENCES

Ağar, Ü., 1977, Demirözü (Bayburt) ve Köse (Kelkit) bölgesinin jeolojisi: İst. Univ. Fen Fak., K.T.Ü. Matbaası, Thesis of Doctorate, Trabzon, 59.

Ağralı, B.; Akyol, E. and Konyalı, Y., 1966, Kelkit-Bayburt Jurasiğinde üç kömür damarının palinolojik etüdü: Türkiye Jeol. Kur. Bult., 10, 155-158.

Akyürek, B. and Soysal, Y., 1983, Biga yarımadası güneyinin (Savaştepe-Kırkağaç-Bergama-Ayvalık) temel jeoloji özellikleri: MTA Bull., 95/96, 1-13.

Alp, D., 1972, Amasya yöresinin jeolojisi: İst. Univ. Fen. Fak. Monografileri, 22, 101, İstanbul.

Ayaroğlu, H., 1979, Bozüyük metamorfitlerinin petrokimyasal özellikleri: Türkiye Jeol. Kur. Bult., 22, 101-107.

Bektaş, O., 1981, Kuzey Anadolu Fay Zonunun Erzincan Tanyeri Bucağı yöresindeki jeolojik özellikleri ve yerel ofiyolit sorunları: Karadeniz Tek. Univ., Thesis of Doctorate, 193, Trabzon.

Bergougnan, H., 1975, Presence de trois unites charrie'es a la bordure sud des Pontides dans le Haut-Kelkit. Ages et sensde mises en place: C.R. Ac. Sci., 280, 2199-2201, Paris.

———, 1975, Structure de la Chaine pontique dans le Haut-Kelkit (Nord-Est de l'Anatolie): Bull. Soc. Geol. 13, 675-686, France.

Bingöl, E.; Akyürek, B. and Korkmazer, B., 1975, Biga yarımadasının jeolojisi ve Karakaya Formasyonunun bazı özellikleri: Cumhuriyetin 50. Yılı Yerbilimleri Kongresi, Tebliğler, MTA, 70-77, Ankara.

Blumenthal, M., 1950, Orta ve Aşağı Yeşilırmak bölgelerinin jeolojisi hakkında: MTA, Publ, D, no. 4, 153, Ankara.

Çoğulu, E., 1970, Gümüşhane ve Rize granitik plütonlarının mukayeseli petrografik ve jeokronometrik etüdü: İst. Tek. Univ., Thesis (Unpublished).

Delaloye, M.; Çoğulu, E. and Chessex, R., 1972, Etude geochronometrique des massifs cristallens de Rize et de Gümüşhane, Pontides orientales (Turquie): C.R. des Seances, 7, 43-52, SPHN Geneve.

Erol, O., 1956, Ankara güneydoğusundaki Elma Dağı ve çevresinin jeoloji ve jeomorfolojisi üzerinde bir araştırma: MTA Publ., D/9, 99, Ankara.

Gedikoğlu, A., 1976, Giresun H41-d3 paftasının jeolojisi: Maden Tetkik ve Arama Enst. Rep., 5927 (unpublished).

———, 1978, Harşit granit karmaşığı ve çevre kayaçları (Giresun-Doğankent): Karadeniz Tek. Univ. Thesis, (unpublished).

Göksu, E., 1962, Türkiye Jeoloji Haritası, Samsun paftası: MTA, Enst., Ankara.

Holland, T.J.B. and Norris, R.J., 1979, Deformed pillow lavas from the Central Hole Tauern, Austria and their bearing on the origin of epidote-banded greenstones: Earth Planetary Sci. Letters, 43, 397-405.

Hutchinson, R.M , 1960, Petrotectonics and petrochemistry of Late Precambrian batholiths of Central Texas and the north end of Pikes Peak batholith, Colorado: Rept. 21st. Sess., Int, Geol., Cong., Pt. 14, 95-107.

IUGS Subcomission on the Systematics of Igneous Rocks, 1973, Classification and nomenclature of plutonic rocks, recommendatiohs: N. Jb. Miner. Mh., 4, 149-164.

Ketin, İ., 1948, Über die tektonisch-mechauischen Folgerungen aus den grossen anatolischen Erdbeben des letzten Dczenniums: Geol. Rundschau, 36, 77-83.

———, 1951, Bayburt bölgesinin jeolojisi: İst. Univ. Fen Fak. Mecm., B, 16, 113-127.

———, 1966, Anadolu'nun tektonik birlikleri: MTA Bull., 66, 20-34.

Koçyiğit, A., 1979, Tekneli bölgesinin (Tokat güneyi) tektonik özelliği: TÜBİTAK Project Rep. (unpublished).

Nebert, K., 1961, Kelkit Çayı ve Kızılırmak (Kuzey Anadolu) nehirleri mecra bölgelerinin jeolojik yapısı: MTA Bull., 57, 1-49.

———; 1964. Şiran güneybatısıdaki (Kuzeydoğu Anadolu) Kelkit Çayı üst mecrasının jeolojisi hakkında: MTA Bull., 62, 41-57.

Özcan, A.; Erkan, A.; Keskin, A.; Oral, A.; Özer, S.; Sümengen, M. and Tekeli, O., 1980, Kuzey Anadolu Fayı-Kırşehir Masifi arasının temel jeolojisi: MTA Rep., 6722 (unpublished).

Pelin, S., 1977, Alucra (Giresun) güneydoğu yöresinin petrol olanakları bakımından jeolojik incelemesi: Karadeniz Tek. Univ. Publ., 87, 103, Trabzon.

———; Özsayar, T.; Gedikoğlu, A. and Tülümen, E., 1982, Doğu Pontidler'de Üst Kretase yaşlı kırmızı biyomikritlerin oluşumu: Karadeniz Univ. Yerbilimleri Bull., 2, 69-80.

Reesor, I.E., 1958, Dewar Creek Map-area with special emphasis on the White Creek batholith, British Columbia: Geol. Surv. Canada Mem., 292.

Schultze-Westrum, H.H., 1961, Giresun civarındaki Aksu deresinin jeolojik profili, Kuzeydoğu Anadolu'da Doğu Pontus cevher ve mineral bölgesinin jeolojisi ve maden yatakları ile ilgili mütalaalar: MTA Bull., 57, 63-71.

———, 1962, Das geologische Profil des Aksudere bei Giresun (Nordost Anatolien): Bayerische Akademie der Wisscnschaften, Abhandlungen Neue Folge, 109, 25-48.

Seymen, İ., 1975, Kelkit vadisi kesiminde Kuzey Anadolu Fay Zonunun tektonik özelliği, İst., Tek. Univ., 192, Istanbul.

Şengör, A.M.C., 1979, The north Anatolian transform fault: its age, offset and tectonic significance: J. Geol. Soc., 136, 269-282, London.

———; Yılmaz, Y. and Ketin, İ., 1980, Remnants of a pre-Late Jurassic ocean in northern Turkey: Fragments of Permian-Triassic Paleo-Tethys Geol. Soc. Am. Bull., 91, 599-609.

———. and Yılmaz, Y., 1981, Tethyan evolution of Turkey: a plate tectonic approach: Tectonophysics, 75, 181-241.

Shido, F. and Miyashiro, A., 1959, Hornblendes of basic metamorphic rocks: Tokyo Univ. Fac. Sci., Sec. 2, 12, 85-102.

Taner, M.F., 1977, Etude geologique et petrographique de la region de Güneyce-İkizdere, situee au Sud de Rize (Pontides Orientales, Turquie): Cenevre Univ. Ph. D. Thesis, 1788.

Tatar, Y., 1975, Refahiye'nin güneydoğusunda Conur Köyü yöresi ofiyolitleri: Cumhuriyetin 50. Yılı Yerbilimleri Kongresi, Tebliğler, MTA, 435-444, Ankara.

Tekeli, O., 1981, Toroslar'da, Aladağ ofiyolitli melanjının özellikleri: Türkiye Jeol. Kur. Bult., 24, 57-64.

———, 1981, Subduction complex of pre-Jurassic age, northern Anatolia, Turkey: Geology, 9, 68-72.

Turner, F.J., 1981, Metamorphic Petrology: McGraw-Hill Book Company, New York, 524.

Yılmaz, Y., 1972, Petrology and structure of the Gümüşhane granite and the surrounding rocks. N.E. Anatolia: Univ. of London, Ph. D. Thesis (unpublished).

———, 1977, Bilecik-Söğüt dolayındaki «eski temel karmaşığının petrojenetik evrimi: İst. Univ., Thesis (unpublished).

Zankl, H., 1961, Magmatismus und Bauplan des ostpontischen Gebirges im Querprofil des Harşit Tales, NE Anatolien: Geol. Rundschau, 51, 218-235.