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Tectonic setting of some Pre-Liassic low grade metamorphics in Northern Anatolia

Kuzey Anadolu'daki bazı Liyas öncesi düşük dereceli metamorfiklerin tektonik konumu

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ABSTRACT

In Northern Anatolia, along the İzmir-Ankara-Erzincan Suture Belt, low grade metamorphic assemblages display strong similarities in their pre-metamorphic stratigraphy. However, the classification of these assemblages with respect to their stratigraphy, internal organization, age and boundary relations is still not clear due to limited number of studies.

In this study, the Amasya (NE Central Anatolia) region is selected and studied to shed some light onto the correlation of metamorphic units in Northern Anatolia. Tectonostratigraphically, three distinctly different metamorphic rock assemblages are differentiated on the basis of their internal organizations, relict textures and structures, and pre-metamorphic lithologies, as bottom to top; 1) grayish black schists with quartz boudins and veins, 2) metabasic schists, 3) metabasic schists with marble blocks and/or boudins. The structurally lower unit is originally a clastic sequence which is made up of shales, sandstones, cherts and calcareous clastics. It is tectonically overlain by metabasic schists, protoliths of which are volcanics-volcaniclastics and carbonates. The upper unit is composed of huge marble blocks and/or lenses embedded within a volcanic sequence.

The protoliths of the low grade metamorphics can be interpreted as an arc-related basinal sequence being metamorphosed by regional dynamothermal metamorphism during Late Paleozoic. A later (Early Mesozoic?) HP/LT overprint is represented by Na-amphibole overgrowths indicating that they were very probably incorporated into the Cimmeride orogen. Considering the protolithologies these metamorphics can be correlated with Agvanis and Yenişehir low grade metamorphics, which all are believed to be in Late Paleozoic age.

Key words: pre-metamorphic stratigraphy, low grade metamorphics, Late Paleozoic, NE Central Anatolia.

ÖZ

Kuzey Anadolu'da, İzmir-Ankara-Erzincan Kenet Kuşağı boyunca yer alan düşük dereceli metamorfik toplulukların metamorfizma öncesi litolojileri büyük benzerlikler sunar. Ancak, bu metamorfitlerin metamorfizma öncesi litolojilerine, stratigrafilerine, iç düzenlemelerine, yaş ve dokanak ilişkilerine göre sınıflandırılması metamorfikler üzerine yapılmış çalışmaların sınırlı olmasından dolayı halen netlik kazanamamıştır.

Bu çalışmada, Amasya bölgesi, Kuzey Anadoludaki metamorfik birimlerinin deneştirilmesine ışık tutabilmesi amacı ile seçilmiştir. Bu yöredeki metamorfik kayalar tektonostratigrafik olarak iç düzenlemeleri, kalıntı dokuları ve yapıları, ve metamorfizma öncesi litolojilerine göre belirgin olarak üç farklı metamorfik kaya topluluğuna ayrılmıştır; bunlar tabandan tavana, 1) kuvars budinleri ve damarları içeren grimsi siyah şistler, 2) metabazik şistler, 3) mermer blokları ve/veya budinleri içeren metabazik şistlerdir. Tabanda birim, ilksel olarak klastik bir istif olan şeyllerden, kumtaşlarından, çörtlerden ve kalkerli kumtaşlarından oluşur. Bu birim, ilksel olarak volkanik-volkaniklastik ve karbonatlardan oluşan metabazik şistler tarafından tektonik olarak üzerlenir. Üst birim ise devasa mermer blokları ve/veya budinleri içeren volkanik istiften oluşur.

Geç Paleozoyik'te bölgesel dinamotermal metamorfizma tarafından değişime uğratılmış olan düşük dereceli metamorfiklerin, metamorfizma öncesi litolojileri yay ile ilgili bir basen ürünü olarak yorumlanabilir. Daha sonraki

bir YB/DS metamorfizması (Erken Mezozoyik?) sodik amfibol gelişimi ile temsil edilmektedir. Bu olgu birimlerin olasılıkla Kimmerid orojenezine katıldıklarını göstermektedir. Geç Paleozoyik yaşlı oldukları düşünülen bu metamorfikler, metamorfizma öncesi kaya birimleri esas alınarak Agvanis ve Yenişehir düşük dereceli metamorfikleri ile deneştirilebilirler.

Anahtar kelimeler: metamorfizma öncesi stratigrafi, düşük dereceli metamorfikler, Geç Paleozoyik, KD Orta Anadolu.

INTRODUCTION

Overprinting of series of Phanerozoic geologic events caused complex terrain evolutions in Northern Anatolia. As a result, it is hard and problematic to differentiate the discontinuous and scattered northern metamorphic units which are situated to the north of southern limit of İzmir - Ankara - Erzincan Suture Belt (IAES) (Fig.1).

Exposures of the various age and type of metamorphics are widespread in Pontide belt (Blumenthal, 1950; Erol, 1961; Nebert, 1961; Alp, 1972; Bingöl et al., 1975; Brinkman, 1976; Koçyiğit, 1979, 1987; Öztürk, 1979; Krushensky et al., 1980; Özcan et al., 1980; Tekeli, 1981; Okay, 1983, 1984, 1989; Akyürek et al., 1984; Genç, 1987; Göncüoğlu et al., 1987; Yılmaz et al., 1990; Okay et al., 1990; Koçyiğit et al., 1991; Rojay, 1993; Tüysüz, 1996). However, the differentiation of metamorphics with respect to their pre-metamorphic stratigraphy, internal organiza-tion, age and boundary relations and tectonic settings is still not clear due to limited number of studies on petrography, geochemistry, petrofabric analysis, radiometric and paleonto-logical age dating and finally, the contro-versial, confusive and misusage of the nomenclature, especially the "Karakaya" terminology.

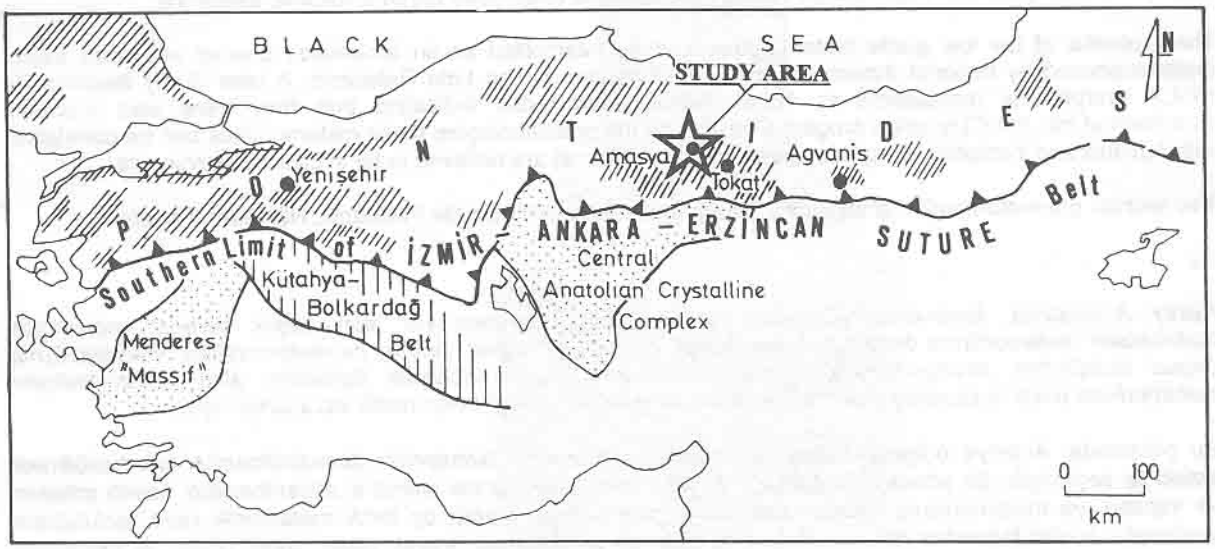

Figure 1. Tectonic map showing the distrubition of metamorphic rocks in northern Anatolia and the location of the study area (modified from Brinkman, 1976).

Şekil 1. Kuzey Anadolu'da yer alan metamorfik kayalarının dağılımını ve çalışma alanını gösteren tektonik harita (Brinkman, 1976'dan değiştirilerek alınmıştır).

Various different scenarios to the evolution of the Tethys are proposed in Northern Anatolia (Bailey and McCallian, 1953; Bingöl et al., 1975; Şengör et al., 1980, 1984; Şengör and Yılmaz, 1981; Yılmaz, 1981; Güvenç and Konuk, 1981; Tekeli, 1981; Şengör, 1984; Yılmaz and Tüysüz, 1988; Göncüoğlu, 1989; Okay, 1989; Yılmaz, 1990; Tüysüz, 1990; Okay et al., 1990; Koçyiğit et al., 1991; Genç and Yılmaz, 1995; Yılmaz et al., 1995) due to various proposed ages, different boundary relations and different tectonic settings for low grade metamorphics along northern belt in Anatolia (Erol, 1961; Öztürk, 1979; Genç, 1987; Yılmaz et al., 1990, 1995; Yılmaz, 1990; Genç and Yılmaz, 1995; Koçyiğit, 1991; Koçyiğit et al., 1991; Kaya, 1991; Rojay, 1993; Tüysüz, 1996). In recent studies, the pre-Jurassic tectonostratigraphic units of the Pontide Belt were reassembled as the "Sakarya Composite Terrane" suggesting the presence of Late Paleozoic "terranes" next to Early Mesozoic "Paleo-Tethyan" ones (Göncüoğlu, 1993; Göncüoglu and Sassi, 1993; Göncüoğlu et al., 1994).

In this study, the metamorphic sequences will be stratigraphically and petrographically documented from Amasya region. It is presumed that the correlation of the Amasya metamorphics with the low grade metamorphic sequences having better boundary relations in NW Anatolia may shed some light onto the evolution of metamorphics in Northern Anatolia regarding to the age, boundary relations and possible tectonic setting of the metamorphic assemblages.

TECTONOSTRATIGRAPHY

The metamorphics are one of the basement units of the Mesozoic sequences in Amasya region which consist mainly of low grade metamorphic rocks (Fig.2). The low grade metamorphics which were named as Tokat Group (Blumenthal, 1950) are unconformably overlain by Liassic clastics.

The Amasya region is made of numerous tectonic slivers, that differ in their ages, stratigraphies and internal organizations (Fig. 2). Besides the metamorphic tectonic slivers, tectonic slivers of the Triassic Devecidağ "Complex" (Öztürk, 1979; Özcan et al., 1980; Rojay, 1995), located to the north and south of the area, are composed of huge blocks of Carboniferous, Permian and Triassic limestones, and a few metamorphics, set in greywackes and slates with spilitic basalts and tuffs displaying a matrix relation with the blocks. This "Complex" will be probable the equivalent units of Karakaya "Unit" which plays an important role in the evolution of the Amasya region (Rojay, 1995). However, it is out of the scope of this study.

The main part of the metamorphic tectonic slivers in the study area are represented by metamorphic sequences dominantly consisting of metavolcanic, metavolcaniclastic, metaclastic rocks and metacarbonates-silicates with a minimum observable thickness of about 310 meters. Tectonostratigraphically, three distinctly different metamorphic rock assemb-lages are differentiated on the basis of internal organizations, relict textures and structures, and pre-metamorphic lithologies. These are: (1) Grayish-black schists with quartz boudins and veins, (2) Metabasic schists, (3) Metabasic schists with marble blocks and/or boudins (Fig. 3).

In the measured section, along the southern slopes of Karasanlar ridge (Figure 2 and 3), the sequence starts with the grayish black and intensely deformed schists which include muscovite-chlorite-calcite-quartz-albite schist (metaclastic), muscovite bearing quartz schist (metachert), quartz-muscovite±albite ± chlorite schist (metachert), quartz - albite - muscovite schist (metapelitic rock) and tourmaline bearing chlorite - sericite - calcite - albite schist (metacarbonate-siltstone) lithologies. This facies is characterized by the presence of schistose texture and quartz boudins.

Tectonically, the sequence continues with light green-green schists (chlorite-actinolite-epidote - muscovite-albite schist) with a layer of stilpnomelane - chlorite - epidote - albite schist (metatuffaceous unit) and is followed by dominantly green - yellowish green - white massive to laminated marble-schist (epidote - actinolite - Na-amphibole chlorite schist with nematoblastic texture) alternation. Alternation of green, thin-bedded to laminated siliceous marbles with metabasic schists (epidote-actinolite-chlorite schist, quartz-muscovite-chlorite schist and chlorite-quartz-albite-calcite ± epidote schist) grade upward into metabasic schists (epidote-actinolite-chlorite schist) and to thin laminated, banded, mylonitized marble bands (chlorite-albite-calcite calc-schist) which are alternating with metabasic schists (epidote

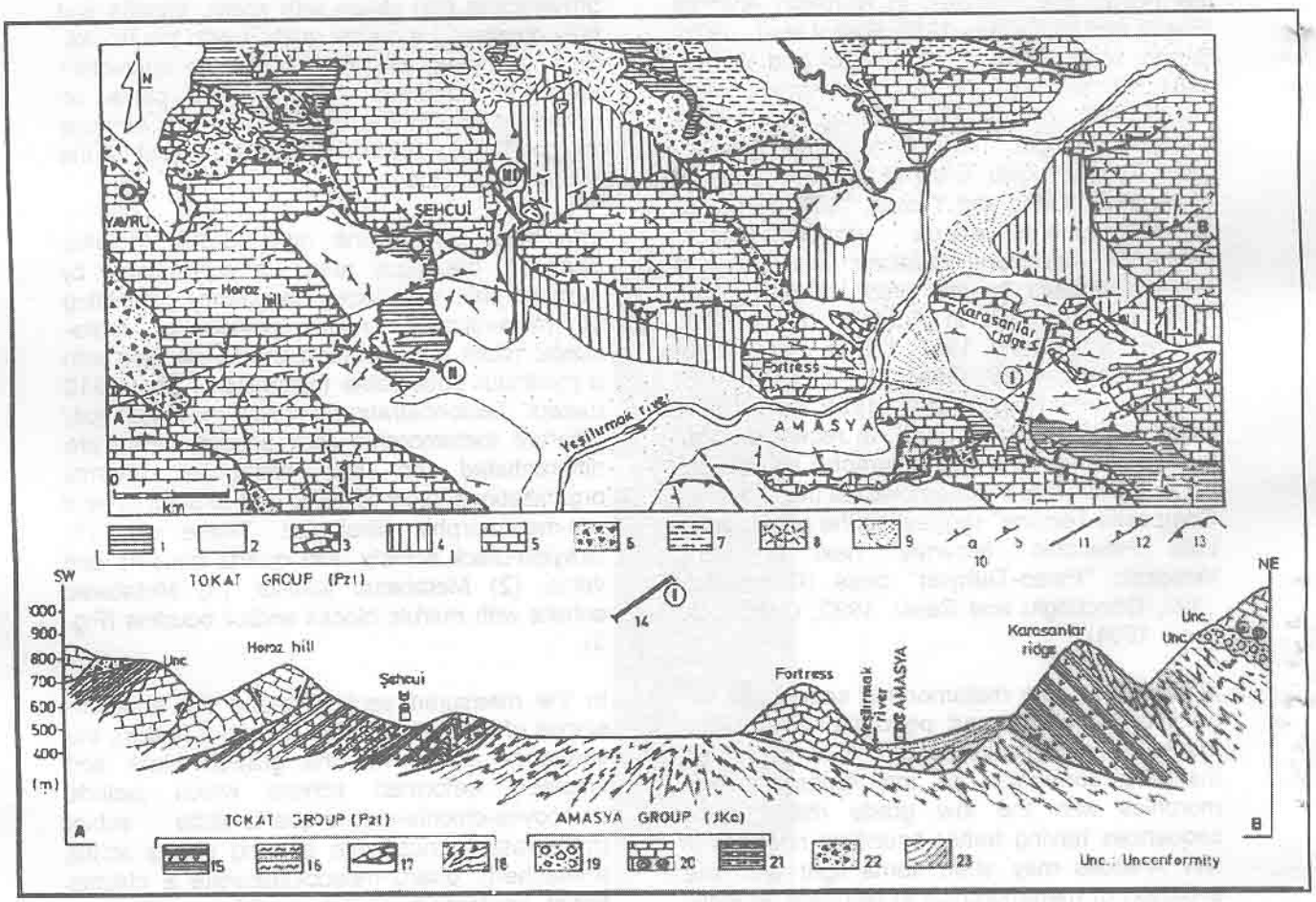

Figure 2. Simplified geological map with a detailed cross-section showing the distribution of low grade metamorphics and their relationships with other rock units in Amasya region (Simplified from Rojay, 1993). 1. Metaclastics, 2. Metavolcaniclastics and metavolcanics, 3. Marble blocks/boudins and 4. Disordered-chaotic metamorphics of pre-Liassic low grade metamorphics (1-4:Tokat Group), 5. Liassic-Cenomanian clastics and carbonates (Amasya Group), 6. Cretaceous ophiolitic melange (North Anatolian Ophiolitic Melange), 7. Campanian-Maastrichtian fore-arc units (Karatepe and Kışlacık Groups), 8. Neogene dacitic intrusions, 9. Quaternary alluvium and alluvial fan, 10. Attitude of bed (a) and schistosity (b), 11. Fault, 12. Reverse fault, 13. Overthrust, 14. Line of section, 15. Metavolcaniclastics and metavolcanics, 16. Metaclastics, 17. Marble blocks/boudins and 18. Disordered-chaotic metamorphics of pre-Liassic low grade metamorphics (15-18:Tokat Group), 19. Liassic clastics-bioclastics, 20.Callovian-Valanginian carbonates with ammonitico rosso facies, 21. Aptian-Cenomanian carbonates-clastics (19-21:Amasya Group), 22. Cretaceous ophiolitic melange (North Anatolian Ophiolitic Melange), 23. Quaternary alluvial fan.

Şekil 2. Amasya bölgesindeki düşük dereceli metamorfiklerin dağılımını ve diğer kaya birimleri ile olan ilişkilerini gösteren sadeleştirilmiş jeoloji harita ve ilgili detay enine kesit (Rojay, 1993'dan sadeleştirilerek alınmıştır). 1. Metaklastikler, 2. Meta-volkaniklastikler ve metavolkanikler, 3. Mermer blokları/budinleri ve 4. Düzensiz-karışık metamorfikler (Liyas öncesi düşük dereceli metamorfikler)(1-4:Tokat Grubu), 5. Liyas-Senomaniyen yaşlı klastikler ve karbonatlar (Amasya Grubu), 6. Kretase yaşlı ofiyolitik karışık (Kuzey Anadolu Ofiyolitik Karışığı), 7. Kampaniyen-Maastrichtiyen yaşlı yayönü birimleri (Kışlacık ve Karatepe Grupları), 8. Neojen yaşlı dasitik sokulumlar, 9. Kuvaterner yaşlı alüvyon ve alüvyon konileri, 10. Tabaka (a) ve yapraklanma (b) doğrultuları/eğimleri, 11. Fay, 12. Ters fay, 13. Bindirme, 14. Kesit cizgisi, 15. Metavolkaniklastikler ve metavolkanikler, 16. Metaklastikler, 17. Mermer blokları/budinleri, ve 18. Düzensiz-karışık metamorfikler (Liyas öncesi düşük dereceli metamorfikler)(15-18:Tokat Grubu), 19. Liyas yaşlı klastikler ve biyoklastikler, 20. Kalloviyen-Valanjiniyen yaşlı "ammonitico rosso" fasiyesi içeren karbonatlar, 21. Aptiyen-Senomaniyen yaşlı karbonatlar-klastikler (19-21:Amasya Grubu), 22. Kretase yaşlı ofiyolitik karışık (Kuzey Anadolu Ofiyolitik Karışığı), 23. Kuvaterner yaşlı alüvyon konisi.

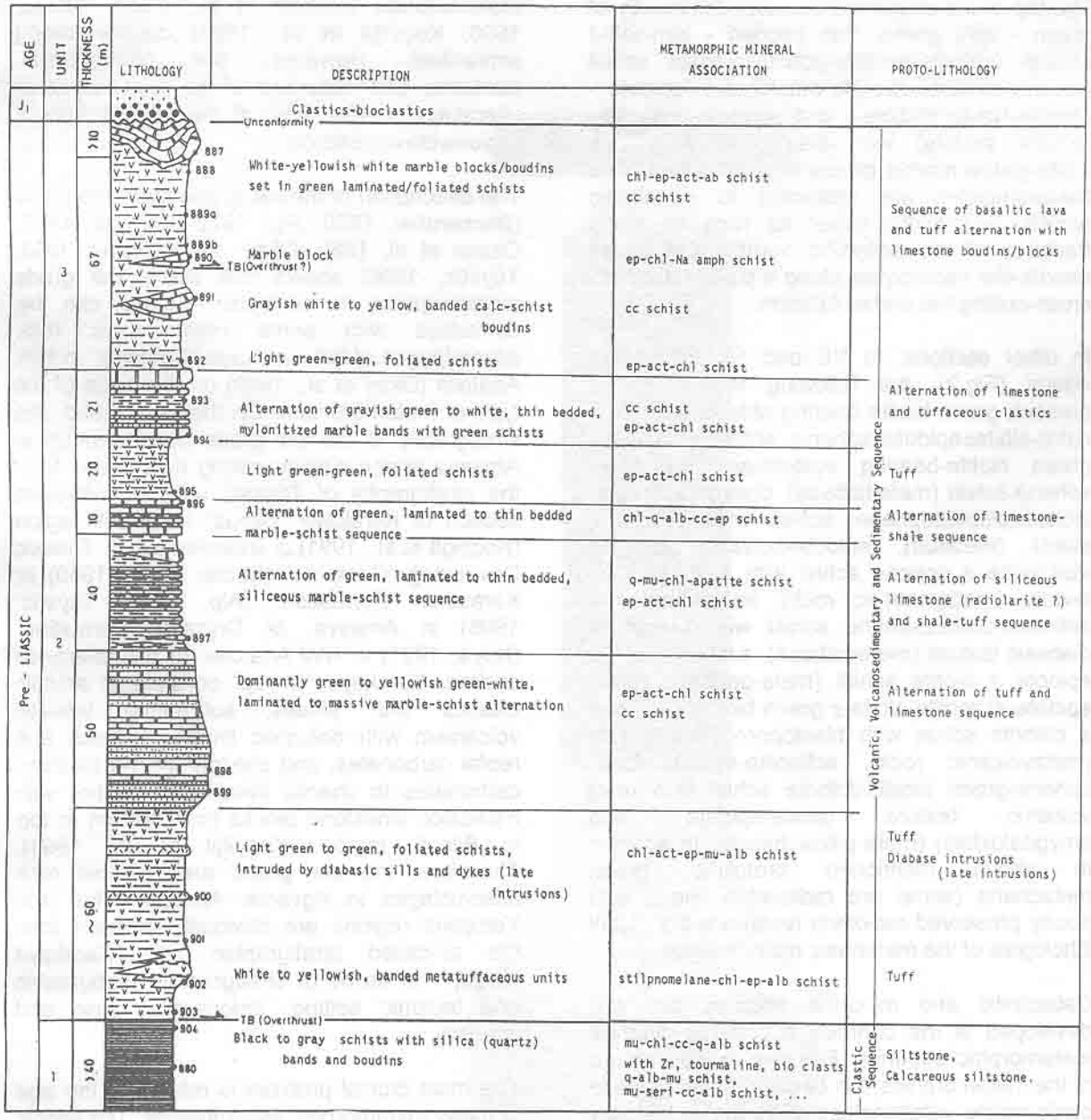

Figure 3. The tectonostratigraphic columnar section of low grade metamorphics in Amasya region. Locality: Southern slope of Karasanlar ridge, E of Amasya. Numbers on tectonostratigraphic columnar section indicate sample locations.

Şekil 3. Amasya bölgesindeki düşük dereceli metamorfiklerin tektonostratigrafik kesiti. Kesit alanı: Amasyanın doğusundaki Karasanlar sırtının güney yamaçı. Tektonostratigrafik kesit üzerindeki sayılar örnek noktalarını gösterir.

actinolite-chlorite±albite schist). This part of the sequence is dominanted by metavolcanic rocks. The top of the sequence consists dominantly of green - light green, thin bedded - laminated schists (chlorite-epidote-actinolite-albite schist rich in nematoblastic Na-amphiboles, epidote - chlorite-Na-amphibole- and epidote-actinolite-chlorite schists) with dismembered grayish white-yellow marble blocks and/or boudins. The Na-amphiboles are restricted to metabasic schists and occur either as rims or along fractures of the actinolitic hornblendes or as needle-like microcrysts along s-planes distinctly cross-cutting the earlier foliation.

In other sections, to NE and SW of Şehcui village (Fig.2), the following lithologies are present; green biotite bearing chlorite-actinolite-calcit-albite±epidote±sphene schist (metatuff), green biotite-bearing epidote-actinolite-albite-sphene schist (metadiabase), chlorite-actinolite-albite±epidote±sphene schist with porphyroblasts (metatuff), epidote-actinolite-albite ± muscovite ± sphene schist with relict igneous texture (metagabbroic rock), epidote-chlorite-actinolite-albite±sphene schist with preserved diabasic texture (metadiabase), actinolite-albite-epidote ± biotite schist (meta-gabbroic rock), epidote-actinolite-albite ± green biotite ± sphene ± chlorite schist with blastoporphyritic texture (metavolcanic rock), actinolite-epidote-albite-sphene-green biotite-chlorite schist with relict volcanic texture (albite-epidote filled amygdaloidals) (meta-pillow basalt). In addition to above mentioned protoliths, green metacherts (some are radiolarian cherts with poorly preserved radiolaria tests) are significant lithologies of the metabasic assemblages.

Cataclastic and mylonitic textures are well developed at the contacts of various different metamorphic subunits. Besides chaotic nature of the metamorphics, the bedding attitudes have conformable relationships with the schistosity planes where relict textures, structures and pillow structures of the basalts are well preserved.

DISCUSSION AND CONCLUSIONS

In Northern Anatolia, some metamorphic rock assemblages of tectonostratigraphic units are well correlative on the basis of grade and type of metamorphism, pre-metamorphic stratigraphy, tectonic and stratigraphic settings. Especially, Agvanis metamorphics (Okay, 1984), Tokat metamorphics (Blumenthal, 1950; Koçyiğit, 1979; Rojay, 1995) and Yenişehir metamorphics (Yılmaz et al., 1990; Yılmaz, 1990; Koçyiğit et al., 1991) display strong similarities. However, the controversial, confusive and misusage of the rock unit term "Karakaya" cease most of the studies from a regionwide correlation.

The description of the low grade meta-morphics (Blumenthal, 1950; Alp, 1972; Koçyiğit, 1979; Özcan et al, 1980; Okay, 1983; Rojay, 1993; Tüysüz, 1996) shows that these low grade metamorphics in northern Anatolia can be correlated with some metamorphic rock assemblages of the Karakaya "Complex" in NW Anatolia (Okay et al., 1990) on the basis of the type of metamorphism. On the other hand, the stratigraphy of the low grade metamorphics in Amasya region display strong differences from the stratigraphy of Triassic units in reference section of Karakaya "Group" in Bilecik region (Koçyiğit et al., 1991) or elsewhere (e.g. Triassic Devecidağ "Complex" (Özcan et al., 1980) or Karasenir "Formation" (Alp, 1972; Tüysüz, 1996) in Amasya, or Dışkaya "Formation" (Kaya, 1991) in NW Anatolia. In the reference section, Karakaya "Group" consists of arkosic clastics with shales, submarine basaltic volcanism with dolomitic limestone beds and reefal carbonates, and shallow marine platform carbonates to chaotic flyschoidal clastics with Paleozioc limestone blocks from bottom to top in Bilecik region (Koçyiğit et al., 1991). Therefore, the low grade metamorphic rock assemblages in Agvanis, Amasya-Tokat and Yenişehir regions are obviously different than the so-called stratigraphic unit -Karakaya "Group"- in terms of stratigraphy, stratigraphic and tectonic setting, deformation style and intensity.

The most crucial problem is related to the age of these metamorphic assemblages. The widely excepted age for the low grade metamorphics is pre-Liassic due to regionwide Liassic unconformity in northern Central Anatolia (Blumenthal, 1950; Alp, 1972; Öztürk, 1979; Özcan et al., 1980; Koçyiğit, 1987; Koçyiğit et al., 1991; Rojay, 1993, 1995). However, the equivalent low grade meta-morphics in NW Anatolia are unconformably overlain by Triassic clastics (Krushensky et al., 1980; Genç, 1987; Koçyiğit et al., 1991) and even by Permian clastics and carbonates (Genç, 1987). Petrographic studies carried out on the fragments of Triassic clastics showed that

recrystallized Carboniferous and Permian limestone fragments are present as well as metabasic, metafelsic and metapelitic rock fragments (Göncüoğlu et al., 1987; Koçyiğit et al., 1991; Özcan et al., 1980). Therefore, the age of deposition of Triassic Karakaya Group is definitely younger than the low grade metamorphics (Kaya, 1991; Koçyiğit et al., 1991; Yılmaz et al., 1993; Genç and Yılmaz, 1995). An age of 272 ± 3 Ma is obtained by K/Ar radiometric dating from granitoids in NW Anatolia having cross-cutting relationship with medium-low grade metamorphics (Çoğulu and Krummenacher, 1967). On the other hand, Göncüoğlu et al (1992) and Göncüoğlu (1997) described tectonic slivers of Late Paleozoic age from the Central Sakarya region which are very similar to the Amasya metamorphics. These metabasic dominated assemblages are intruded by granitoids. The Triassic Karakaya "Group" clastics overlying these metamorphics are rich in granitic clasts indicating a pre-Triassic granitic magmatism. Therefore, the age of the metamorphism should be older than early Permian, which was the age of granitic intrusions. Even older ages (Middle Carboniferous) are recently reported from metamorphics within some of the tectonic slivers of the Karakaya "Complex" in NW Anatolia (Okay et al., 1996) and ascribed to the evidence for the long suspected (Altınlı, 1975; Yılmaz, 1981; Göncüoğlu et al, 1987; Göncüoğlu, 1989) Hercynian events. Metamorphic rock assemblages which were very similar to those in Amasya region were described from the Biga Peninsula (Okay et al, 1990) as tectonic members of the Permo-Triassic Karakaya "Complex", and Carboniferous and Permian radiolarite blocks are identified from Karakaya "Complex" (Okay and Mostler, 1994). The metamorphic sequence described here, on the other hand, clearly differs from the Karasenir "Formation" (Alp, 1972; Tüysüz, 1996) in Amasya region, which was assumed to be a metaclastic dominated sequence of Paleozoic age. The presence of Early Devonian and Permian blocks within the Karasenir "Formation" was demonstrated in recent studies carried out in Amasya region, (Çapkınoğlu and Bektaş, 1997). That clearly indicates the presence of the equivalent sequences of the Karakaya "Group" in Amasya region.

Moreover, depending on the fossilifereous equivalent units in Kütahya-Bolkardağı Belt (Özcan et al., 1988; Göncüoğlu, 1989; Göncüoğlu et al., 1992), the age of deposition and metamorphism of the assemblage should be Carboniferous. Considering that the Sakarya Zone (Okay, 1984) or the Central Sakarya Terrane (Göncüoğlu et al., 1994) has been seperated from the main bulk of the Tauride-Anatolide Platform due to the opening of the Neo-Tethyan Vardar-Izmir-Ankara Ocean, it is convincing to suggest that Late Paleozoic tectonic fragments of this unit were incorporated to the accretionary prism of the closing Paleo-Tethyan ocean. Therefore, there is no reason not to assume that some of the tectonic slivers within the Karakaya Complex (sensu Okay et al, 1990) or Sakarya Composite Terrane (sensu Göncüoğlu et al, 1994) are Late Paleozoic in age.

In addition to above mentioned relations, the deformation differences between metamorphics and, Permian and Triassic units point out that the low grade metamorphics have undergone different tectonic processes.

Another important problem is related to the paleotectonic setting of the metamorphic assemblage. Depending on the pre-metamorphic lithologies of the sequence (Fig. 3), various rock units of the metamorphics were deposited in a basin where intense basaltic volcanism was active. The extensive distribution of mafic volcanics with pillow basalts, pelagic limestones and possible radiolarites (pelagic influx) may manifest a deep sea depositional setting in an active continental marginal basin which is probably an arc-related basin (Dickinson and Selley, 1979).

Collectively, the metamorphics in Amasya region (Tokat Group) which all are believed to be the equivalent of Agvanis and Yenişehir low grade metamorphics, can be interpreted as arc-related basinal sequence being metamorphosed by dynamothermal meta-morphism during Late Paleozoic.

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