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NEW PETROGRAPHICAL DATA AT THE EASTERN PART OF ALANYA METAMORPHITES (ANAMUR, S.TURKEY)

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ABSTRACT - Investigated area is situated at the eastern part of Alanya metamorphites. Common rock types consist of metapelites, metabasites, marbles and quartzites Field observations and petrographical investigations indicate that metamorphism and deformation histories of Alanya metamorphites in the studied area reveal considerably different features from the western part Mineral compositions show that these rocks are affected from a Barrovian type metamorphism. The existence of staurolite and kyanite minerals especially in metapelitic rocks suggests that the metamorphism conditions in Alanya metamorphites have been reached to high grade amphibolite facies.

INTRODUCTION

Investigated area is located at approximately 10 km northwest of Anamur and is geologically at the eastern part of Alanya metamorphites which crop out between Alanya and Anamur in western part of the middle Taurus (Fig. 1a). First detailed geological studies in Alanya metamorphites are carried out by Blumenthal (1942; 1951); Later on, structural characters and stratigraphic relationships at the western part of middle Taurus is essentially documented by Peyronnet (1967; 1971), Brunn et al., (1973), Özgül (1976), Monod (1977) and Demirtaşlı (1983; 1986; 1988) (Fig. 1b). Structure, stratigraphy and metamorphism of western part of Alanya metamorphites are investigated by Özgül (1983; 1984), Okay and Özgül (1984) and Okay (1989).

In these studies, it is suggested that a nappe structures including three slices and two type of metamorphism, developed in the late Upper Cretaceous at the western part of Alanya metamorphites. First metamorphism type developed under HP/LT conditions have been determined in one of the nappe and the second type greenschist facies metamorphism in all three nappe slices. It is also suggested that greenschist facies metamorphism conditions in the central part of Alanya metamorphites are similar to the western part of Alanya (Ulu, 1.989).

The metamorphites in eastern part of Alanya metamorphites are divided into two parts as Tatlısu çayı metasediments and Azı Tepe marble by İşgüden (1971). Tatlısu çayı metasediments are composed of feldspar, mica and quartz bearing-schist series at the basement and continuing upward by sandy schists, phillite, metasediments and recrystalized limestone which are unconformably covered by Azı Tepe marble. Baydar et al., (1981) have reported fossil findings of Permian age in crystalline limestones at the upper part of this metamorphites and thus, lower part of metamorphites should be older than Permian.

The main objective of this study is the determination of rock types and general metamorphic features of metamorphites at the eastern part of Alanya metamorphites. For this reason, it is especially investigated if the nappe structure and metamorphism characteristics described at the western part, also dominate at the eastern part.

GEOLOGY

Metamorphites in the investigated area comprise the basement of this section. The dominant rock type of metamorphites is metapelites secondly followed by marbles. Metabasites and quartzites are interbedded with these units (Fig. 2).

Metapelitic rocks, forming slight topography, extensively crop out around Çaltıbükü, Sanağaç, Ormancık and Güney districts at northern and northeastern part of investigated area. Macroscopically and mezoscopically, they show green, yellowish green and yellowish gray colors, and their phillitic and schistose texture are dominant. Phillitic rocks especially crop out Güney district. Foliation

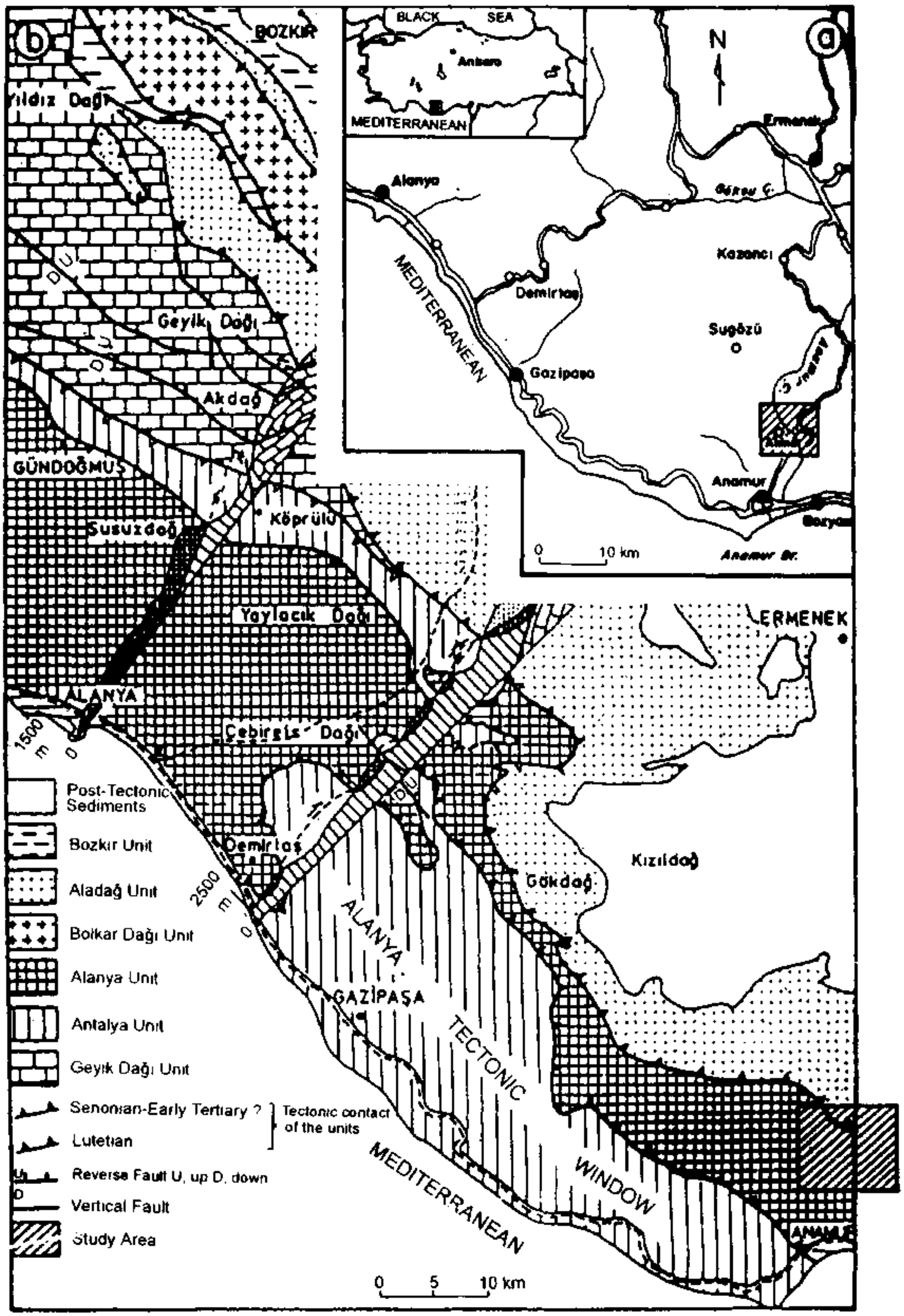


Fig. 1a- Location map of the study area.
1b- Schematic tectonic map of the western part of the Central Taurides (Modified from Özgül, 1983).

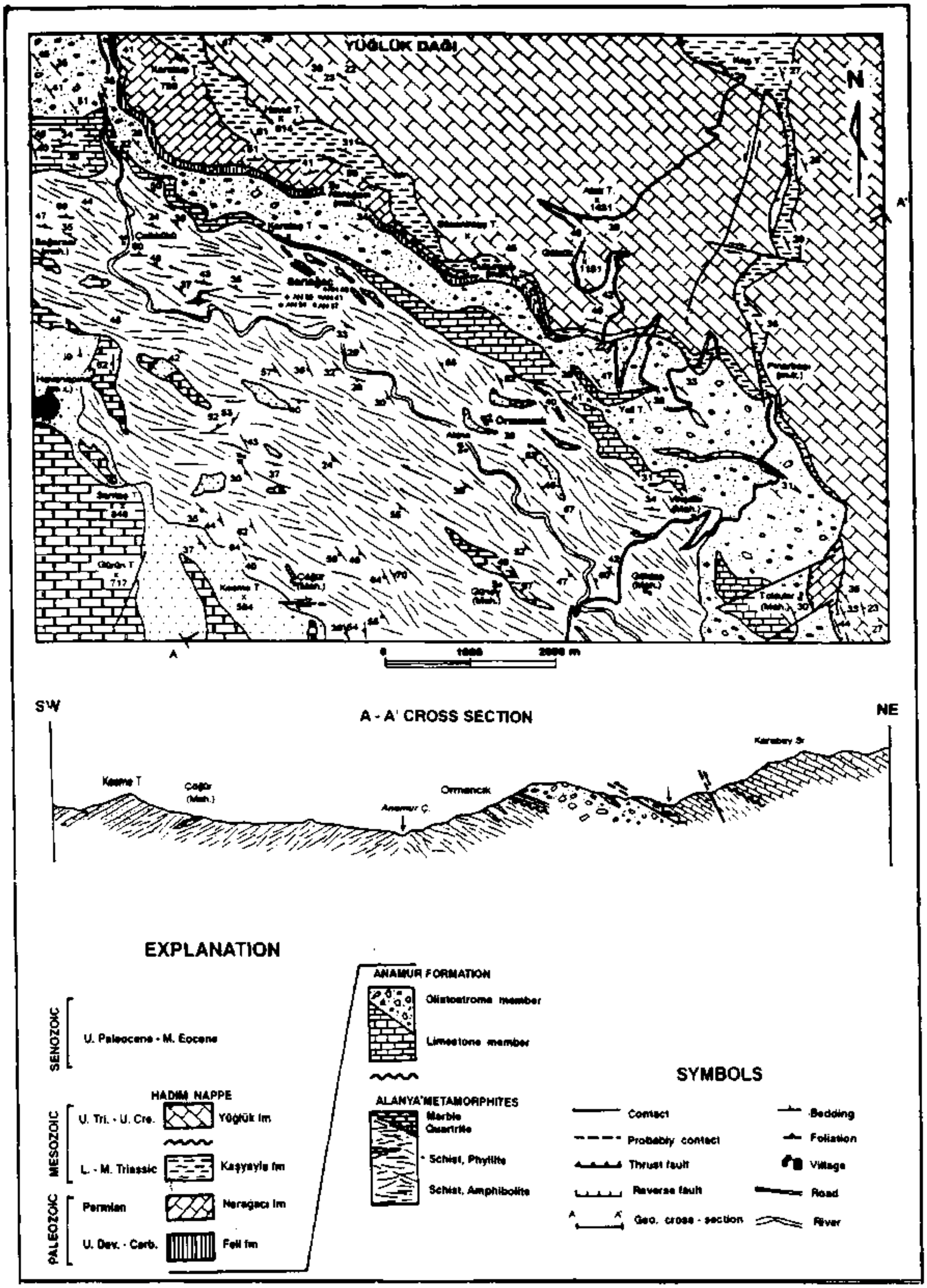


Fig. 2- Geological map of the study area (Işık, 1992).

can be observed at rocks with schistose texture. Coarse-grained muscovite is typically developed along the foliation planes. Brown, medium grained garnet crystals can easily be recognised at the schists around Sarıağaç and Ormancık.

Fine to coarse, elongated structures are developed by quartz rich parts of metapelitic rocks. Folds and faults which reach up from cm to m sizes can clearly be observed at intensively deformed sections. Metabasites are commonly located in metapelitic rocks as intercalations. They are in colours of green, dark-green, greenish black. Greenschist up to 40 cm thicknesses are intercalated in phillitic metabasites of Güney district. On the other hand, amphibolite type metabasites are especially common as interbeds in micaschists around Sarıağaç.

Marble and quartzites cropping out in the western and southwestern parts of investigated area, forming the upper section of metamorphites, exhibit lateral and vertical relationships (Fig. 2). This unit is observed as lenses together with schists around Ormancık. The colour of marbles is white and of quartzites gray, white, purple and cream. Both marble and quartzite show medium to thick bed thicknesses. These medium to coarse grained rocks reveal weak foliation.

PETROGRAPHIC FEATURES OF ALANYA MET AMORPHITES

Metapelitic rocks

The rocks consisting phyllite and schist texture by petrographic studies are determined as chlorite-sericite-albite phyllite, chlorite-muscovite-albite schist, chlorite-mica schist, and staurolite-kyanite-garnet-mica schist. Staurolite and kyanite-bearing schists are not widespread and crop out in a limited area (Fig. 2).

Lepidoblastic texture is common in the rocks with phyllitic textures; however, porphyroblastic texture formed by plagioclases are frequently observed. The main mineral components of these rocks are biotite, chlorite, muscovite, quartz and plagiodase. Opaque minerals, tourmaline with idioblastic, prismatic habits and small amounts of apatite are found as accessory components.

General texture of pelitic rocks which are characterized by schistosity is lepidoblastic. Small amounts of porphyroblastic texture are also recognized. The porphyroblasts are usually formed by plagioclase, and less amount of garnet. Staurolite, kyanite, garnet, biotite, muscovite, quartz, and plagioclase are the dominant minerals of pelitic rocks. Opaque minerals and tourmaline exist in these rocks as accessory minerals.

Plagioclase.- It constitutes the 15-40 volume % of the metapelitic rocks. Plagioclases appear as xenoblast porphyroblasts and elongated grains to foliation direction. Crystals showing polisentetic twinning is rare. Abundant quartz and opaque mineral inclusions are located in the crystals. In some samples, plagioclases surround the garnets. This is also important for the mineral growth. The relationships between internal foliation, forming inclusion trails in plagioclase porphyroblasts, and external foliation imply sintectonic growth (Spry, 1976).

Quartz.- Quartz, cpnsisting of 10-35 volume % of rock, is xenoblastic. Elongated grains are parallel to foliation. It shows clear undulatory extinction and cataclastic deformation textures.

Muscovite-Biotite.- These minerals in metapelitic rocks generally extend parallel to foliation planes and vary between 20 and 50 volume % of the rock. Muscovites with hypidioblast and tabular crystal forms constitute two characteristic foliation planes called S_1 and S_2 indicating that rock is at least subjected to two different deformation events. However, biotites which have idioblastic and tabular forms and distinctly pleochroic with light brown to dark brown colours are less than muscovite in amount. Biotites in metapelitic rocks usually are fine grained and extend parallel to S_2 foliation planes.

Garnet.- It forms 5-25 volume % of the rocks and is usually idioblastic or hypidioblastic and is made of from medium to coarse sized porphyroblasts. Quartz, chlorite and biotite are found in garnets as inclusions.

Kyanite- Kyanite is hypidioblast and bent prismatic and bladed parallel to S_2 foliation plane. It consists of 5-10 volume % of the rock together with Staurolite.

Staurolite— It can be easily recognized by pale honey yellow colours. It is found in the rock less than other minerals and forms fine crystals (Fig. 3). Staurolite is usually hypidioblast and prismatic, and extends as elongated grains parallel to S_2 foliation.

Metabastte rocks

Metabasites predominantly consist of chlorite-albite-actinolite schist, garnet-hornblende schist and garnet amphibolite due to the microscopic investigations. General texture of chlorite-actinolite schist is nematoblastic. The main mineral components of these rocks are chlorite, plagioclase and actinolite while titanite, opaque minerals and epidote are other associated minerals. Garnet-hornblende schist and garnet amphibolite represent the metabasites of higher metamorphism conditions. These rocks exhibit nematoblastic-granoblastic textures. Biotite, quartz, garnet, plagioclase and hornblende constitute the main mineral composition and opaque minerals and epidote also exist (Fig. 4).

Hornblende- This mineral with prismatic to tabular forms shows pleochroism colours varying from yellowish green to green. Their abundance varies between 35-60 volume % Hornblendes in foliated metabasites reveal parallelism to the foliation.

Actinolite— Actinolite, consisting of 30-45 volume % of the rock, has prismatic forms. Pale green pleochroism colours and lower extinction angles distinguish actinolite from hornblende.

Plagioclase- Plagioclases with intensive sericitization in metabasite make up of 10-35 volume % of the rocks.

Garnet— Garnets exhibit generally rounded elliptic or angular grain forms and their abundance varies between 5-10 volume%. Atoll texture is typical. Chloritization in the cracks or at the borders of garnet is common.

Marble

Unique mineralogical composition is dominant, created by calcite crystals, in weakly oriented

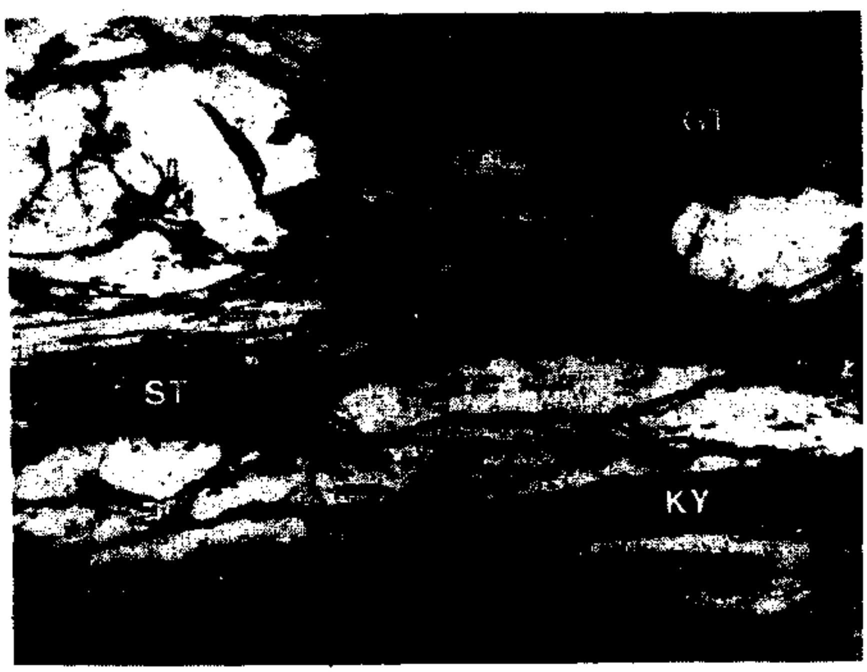
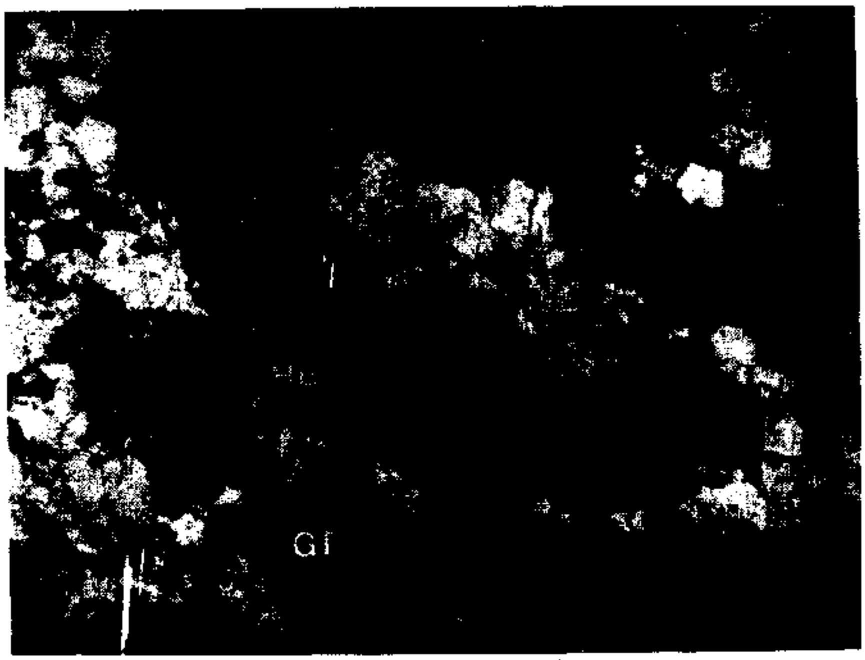


Fig. 3- Staurolite kyanite garnet mica schist. KY= kyanite; GT= garnet; ST= staurolite. Magnification: 63, Parallel nicol.



4- **Garnet amphibolite.** GT= garnet; HBL= hornblende; PL= plagioclase. Magnification: 63, Parallel nicol.

marbles. General texture is granoblastic. Polisentetic twinning in calcite minerals is also very common. Small amounts of quartz and opaque minerals occur in marbles.

Quartzite

General texture of quarizites is granoblastic. Its main mineral component is quartz. Quartzes usually show undulatory extinction. Coarse-grained plagiodase minerals are also observed with quartz inclusions. In some thin section, sericitization are developed in and around the plagioclases while sometimes they become as muscovite occurrences.

METAMORPHISM

Mineral components of common metapelitic rocks in the studied area represent different metamorphic degree conditions. In particular, while mineral composition of rock with phyllite texture and a part of schists typically represent greenschist fades, index minerals found in schists point out existence of amphibolite fades.

Mineral components of politic rocks underwent greenschist facies metamorphism show that metamorphism is reached to garnet zone in Barrovian type metamorphism and is developed under 3-6 kbar pressure and 350-500°C temperature conditions (Winkler, 1979; Yardley, 1989; Barker, 1990). Staurolite and kyanite occurrences, representing amphibolite facies, indicate that the metamorphism in this region has reached to kyanite zone. This shows that metamorphism conditions in this part had been developed at temperatures of 540-600°C, at pressure of 5-8 kbar temperature (Winkler, 1979; Yardley, 1989; Barker, 1990) (Fig. 5).

Metabasic rocks in greenschist facies of the studied area are represented by presence of actinolite. Garnet and green hornblende mineral assemblages appear in the regions with the absence of actinolite. These mineral assemblages show that the metamorphism is developed under amphibolite facies conditions (Barker, 1990).

Field and petrographical studies in studied area, suggest the conclusion that Alanya metamorphites has been affected by Barrovian type progressive metamorphism. Staurolite and kyanite minerals documented in this study reveal that metamorphism in eastern part of Alanya metamorphites has reached the amphibolite facies conditions.

CONCLUSION and DISCUSSION

According to the studies Okay and Özgül (1984) and Okay (1989), three metamorphic nappe slices can be separated. These nappes with different sequences are named from bottom to top as Mahmutlar nappe, Sugözü nappe and Yumrudağ nappe. Mahmutlar nappe consists of mica schists, with quartzite and marbles intercalations and the deposition age of this nappe is Permian. Sugözü nappe, overlying Mahmutlar nappe, contains garnet mica schist and eclogite and blueschists inherited from basic rocks (Okay, 1989). On the other hand, recrystallized limestones are the common rock with calcschist and chlorite schist intercalations in the Yumrudağ nappe.

According to the studies of Okay (1989), a metamorphism with two different phases has been developed in the western part of Alanya metamorphites. First phase is characterized by blueschist and eclogite facies HP/LT metamorphism in only one nappe, namely Sugözü nappe, during Upper Cretaceous. Greenschist facies Barrovian type metamorphism is affected all three nappe slices in the second phase.

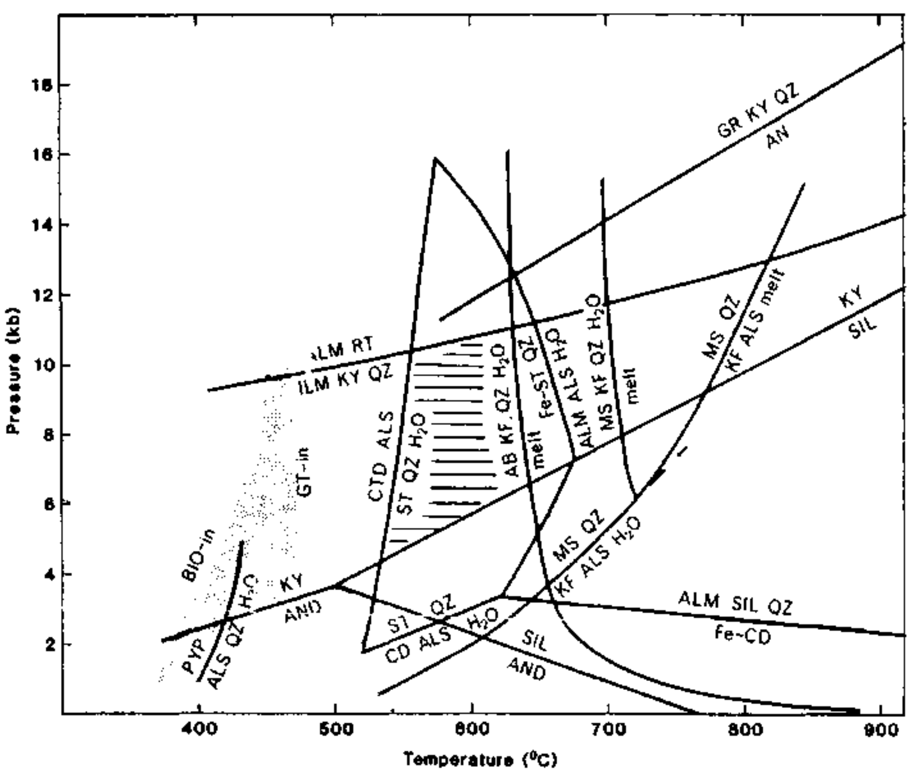


Fig. 5- Petrogenetic grid for pelitic metasediments with P= P_{H_2O} (Simplified from Yardley, 1989). Abbreviations: AB= albite; ALM= almandine; ALS= Al-silicate; AN= anorthite; AND= andalusite; BIO= biotite; CD= cordierite; CDT= chloritoid; GT= garnet; ILM= ilmenite; KF= K-feldspar; KY= kyanite; MS= muscovite; PYP= pyrophyllite; QZ= Quartz; RT= rutile; SIL= sillimanite; ST=staurolite. Stippled bands are approximate conditions of the bioitite and garnet isogrods. The hatched region represents the stability field of bearing-staurolite and kyanite metapelites.

At the eastern part of Alanya metamorphites, however, single phased Barrovian type regional metamorphism is defined by greenschist to amphibolite facies and probably by a progressive metamorphism. In addition, there has been found no implications to a structure consisting nappes in this parts of Alanya metamorphites. Thus, both parts of Alanya metamorphites has different metamorphic and structural character. For this reason, at this stage it is not possible to make any comparison for the metamorphism and deformation histories between both regions. Additionally, another difficulty is raised from the large central region between two metamorphites because of lack of enough information.

However, Barrovian type metamorphism thought developed in different grades and characters in both regions at Upper Cretaceous time makes a possible comparison. With some critical approach, it can be evaluated that the metamorphism at the eastern part is comparable with the second phase of metamorphism developed under greenschist metamorphism conditions at the western part. So, it can be concluded that the metamorphism at the eastern part represents the one of more advanced parts of second phase metamorphism of the western part of Alanya metamorphites.

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