GRAPHITIZATION OF METASEDIMENTARY ROCKS IN THE WESTERN KONYA

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ABSTRACT

The Paleozoic-Mesozoic metasedimentary rocks in the study area are metacarbonate, metachert, metapelite, metasandstone and metaconglomerate. Graphite layers are 1cm to 2m thick, extend laterally for tens of meters and are intercalated with metasedimentary rocks. Generally, the graphite is black in color, with a well developed cleavage which is concordant with the cleavage of the host rocks. In addition, the crystal and flake graphites formed in metasedimentary rocks are mostly aligned parallel to the cleavage planes. These metamorphic rocks are subjected to shearing and granulation providing structural control for the development of graphite. It was probably this phenomenon that first led to emphasize the relationship between graphite and metasedimentary rocks. Graphite mineralization has been controlled by bedding, microfractures and granulations. Briefly, the metamorphism has converted carbonaceous matter into graphite .

Key Words: Konya, metamorphism, graphite, metasedimentary rocks, microfractures

KONYA BATISINDA METASEDİMANTER KAYAÇLARDAKİ GRAFİTLEŞMELER

ÖZET

İnceleme alanındaki Paleozoyik-Mesozoyik yaşlı metasedimanter kayaçlar, metakarbonat, metaçört, metapelit, metakumtaşı ve metakonglomeralardan oluşmaktadır. Bu birimler içinde araseviyeler şeklinde 1cm – 2m kalınlığında ve yanal olarak onlarca metre uzanım sunan grafik bantları gözlenir. Grafitler siyah renkli olup, iyi klivajlanmışlardır ve klivaj düzlemleri yan kayaçlardaki bölgesel klivajlanmaya paralleldir. Bunun yanı sıra, medisedimanter kayaçlar içinde klivaj düzlemlerine parallel olarak yönlenmiş kristal ve pulsu şekilli grafitler de bulunur. Yöredeki metamorfik kayaçlarda gözlenen makaslama ve granülasyon grafit oluşumu için yapısal kontrol oluşturur ve bu olaylar grafitler ile metasedimanterler arasındaki ilişkiyi ortaya koyar. İnceleme alanındaki grafit mineralleşmesi tabakalanma, mikrokırıklar ve granülasyon ile kontrol edilir. Kısaca, sedimanter kayaçlar içindeki karbonlu maddeler, metamorfizma sonucu grafite dönüşmüştür.

Anahtar Kelimeler: Konya, metamorfizma, grafit, metasedimanter kayaçlar, mikrokırıklar.

1. INTRODUCTION

The areas studied in detail are the western of Konya city (figure 1a) and belong to the Afyon-Bolkardağ Belt. Geology and petrology of the blue and green schist facies rocks in the area is described by the Özcan et al., (1988), Eren (1993a, 1993b, 1996a) and Kurt (1994). In the study area three phases of deformation have been recognized. The first deformation event was synchronous or just before the regional metamorphism that affected the whole area during the mid-Cretaceous. In general, the mesoscopic F_1 folds are isoclinal and the flattened limbs are often sheared out parallel and into the regional S_1. The second and third phases of deformation represent post metamorphic episodes and developed type 3 and type 2 refolded folds, crenulation cleavages, kink bands and lineation. Graphite is a widespread constituent of metasedimentary rocks. The graphitization is

primarily dependent up on metamorphic temperature and pressure. This research investigates graphitization in the studied area.

Figure 1. Location and geological map of the study area.

2. ANALYSIS METHODS

Microscopic work was carried out by ore microscopy. For the reflectance measurements, a Leitz-MPV-SP was used. Arithmetic means were calculated for maximum reflectance of the carbonaceous matter measured in each sample. Mineral identification was made by X-ray diffraction methods.

3. GEOLOGICAL SETTING

In the study area, there are two metamorphic units, which are autochthonous and allochthonous. The Miocene-Quaternary aged cover rocks overlie these units by angular unconformity (Figure 1).

The autochthonous unit includes the Upper Permian-Cretaceous Gökçeyurt Group divided into three formations which are gradational to one another. These are, in ascending order, the Upper Permian Derbent formation composed of metacarbonate, phyllite and graphite schists. The Upper Permian-Upper Triassic Aladağ Formation consisting of alternation of metaconglomerate, metasandstone, phyllite and metadolomite, and the Upper Triassic-Cretaceous Lorasdağı Formation comprising a thick sequence of metacarbonate rocks. In the southwest of the study area, the allochthonous Ladik metamorphites, which is Silurian-Mesozoic in age, tectonically

overlie the Gökçeyurt Group (Figure 1). The Ladik metamorphites can be divided into Silurian-Lower Permian aged Sızma group and Upper Permian (?) Mesozoic aged Ardıçlı group. Sızma group included, in ascending order, Silurian-Lower Carboniferous reefal complex of the Bozdağ formation. The Bozdağ formation passes into the Devonian -Lower Permian aged Bağrıkurt formation consisting of metaconglomerate, metasandstone, phyllite, graphitic schist, calc-schist, metachert, metatuff and metaconglomerate. Metamagmatitic rocks, which are composed of hornblende metagabbro, metadolerite, metatrachyandesite, metabasites, metabasalticandesite, high K-metatrachyandesite, cut the Sızma group rocks in different geometrical direction. The Upper Permian (?) to Mesozoic aged Ardıçlı Group unconformably overlying the Sızma Group, is made up of Bahçecik, Ertuğrul and Kızılören Formations. These units laterally and vertically interfinger to each other. The youngest units of the study area, the Upper Miocene-Pliocene aged alluvial fan deposits, lacustrine carbonate, pyroclastic sediment and volcanic rocks cover the older rocks with angular unconformity (Figure 1).

4. GRAPHITE OCCURRENCE

The graphite occurrences are grouped into three by their geographical and lithological distribution; Tepeköy, Meydanköy and Tatköy occurrences. At the north of the Tepeköy, there are four types of graphite (figure 2a).

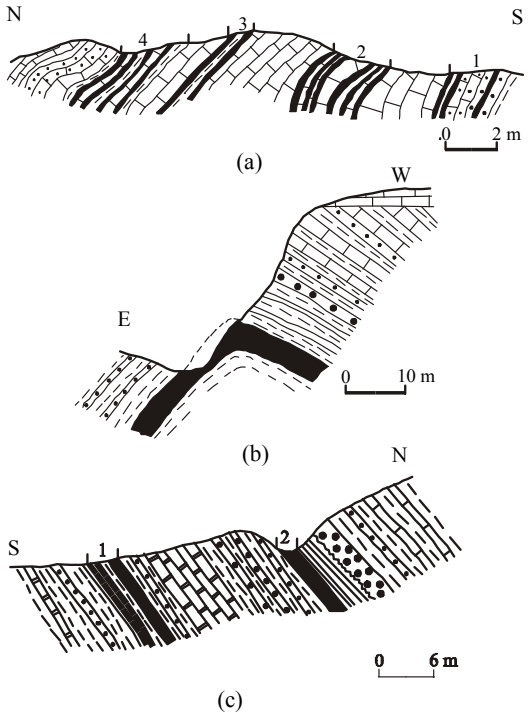

Figure 2. Geological position of the graphites. a) Tepeköy, b)Tatköy, c) Meydanköy.

The first type graphite occurs with in quartzite and its thickness varies between 20-30 cm (Figure $2a_1$). The second and fourth types graphites occur mostly in the calc-schist and crystallized limestone. Their thickness ranges from 1 to 5 m (Figure $2a_{1,4}$). The third type of graphite occurs as intercalations with phyllite and its thickness is about 1m (Figure $2a_3$). Chlorite, calcite and quartz were detected in the samples. At the east of the Tatköy, the graphite bearing zone, which is 50 cm to 2m thick, occurs in metasandstone-phyllite of the Bağrıkurt formation (Figure 2b). The graphite layers are laminated and cleaved by deformation and metamorphism. Chlorite, calcite, muscovite, smectite, feldspar, pyrite and quartz detected in the samples. At one km NW of the Meydanköy, there are two types of graphites (Figure 2c). The first type graphite occurs between phyllite and metasandstone (Figure $2c_1$) and its thickness varies between 1-20 cm. The second types occurs over the phyllite-metasandstone and metaquartz conglomerate and its thickness varies between 2- 2,5m. All types graphite layers

are parallel to surrounding metamorphic rocks.

These graphites are pervasively cleaved and show crenulation cleavage resulting from poly-phase deformation shearing stresses, and metamorphism (Figure 2c$_2$). Milky quartz veins, chlorite, epidote and pyrite are easily detected in the samples.

4.1. X-ray Diffraction and Reflectance of Graphite

X-ray diffraction patterns of this material have shown most of the characteristic peaks of graphite (Figure 3). Average reflectance (R_{mean}) in this material is shown the Table1. While X-ray diffraction patterns of this material indicate graphite, average reflectance (R_{mean}) of this material point to subgraphite.

Table 1. Reflectance in Graphites

Sample No	R_{max} %	R_{min} %	R_{mean} %
1 (Tepeköy)	5.961	3.604	4.652
2 (Tatköy)	5.26	2.487	3.887
3 (Tatköy)	4.08	1.613	3.05
4 (Meydan Village)	5.271	3.408	4.072
5 (Meydan Village)	4.02	3.134	3.294

4.2. Metamorphism and Graphitization

X-ray diffraction patterns and average reflectance of graphites in the study area have pointed to relatively low grade metamorphic, greenschist facies connditions (Table 2). All graphites occur in Palaeozoic metasedimentary rocks of the greenschist facies of relatively low grade metamorphism (Kurt, 1994, 1996, 1997, Eren, 1996b).

Table 2. Shows the relations between reflectance, interlayer spacing d_{002}, facies (F.J.Turner, 1968) and grades (Winkler, 1974).

Metamorphic grade	Facies-subfacies		R_{max}, oil	d_{002}
According to H.G.F. Winkler, 1974	According to F.J. Turner, 1968		%	A^0
Very low	Zeolite		2-4	3.75-3.50 3.43-3.40
Low	Greenschist	Chlorite	3-6.5	3.44-3.37 3.40-3.38
		Biotite	6.5-9	3.36-3.35 3.37-3.36
Medium	Amphibolite		9-12	3.36-3.35 3.358-3.357 3.37-3.36

The pressure- temperature of surrounding metamorphic environment was calculated to be 3-6 Kbar and 350-450 ^oC for greenschist facies. The rocks include typical greenschist minerals, such as actinolite, stilpnomelane, chlorite, chloritoid, crossite and epidote (Kurt, 1994). Two views exist about occurrences of graphite resulting from regional metamorphism : According to the first view, the graphite is altered from organic matter formerly present in the sediments, and to the second view, it results from the breakdown of calcium carbonate. Black, carbonaceous limestones, when metamorphosed, yield white marbles with disseminated graphite (Jensen and Bateman, 1979). In the study area, all of the graphite occurrences are parallel to the bedding of the surrounding metasedimentary rocks. This indicates that the graphite layers were formed by the transformation of carbonaceous material, which is accumulated with the surrounding rocks. Also the graphite within the fractures

were formed by the migration of the previously formed graphite as chlorite, quartz and calcite minerals to the these fractures, during the deformation and metamorphism.

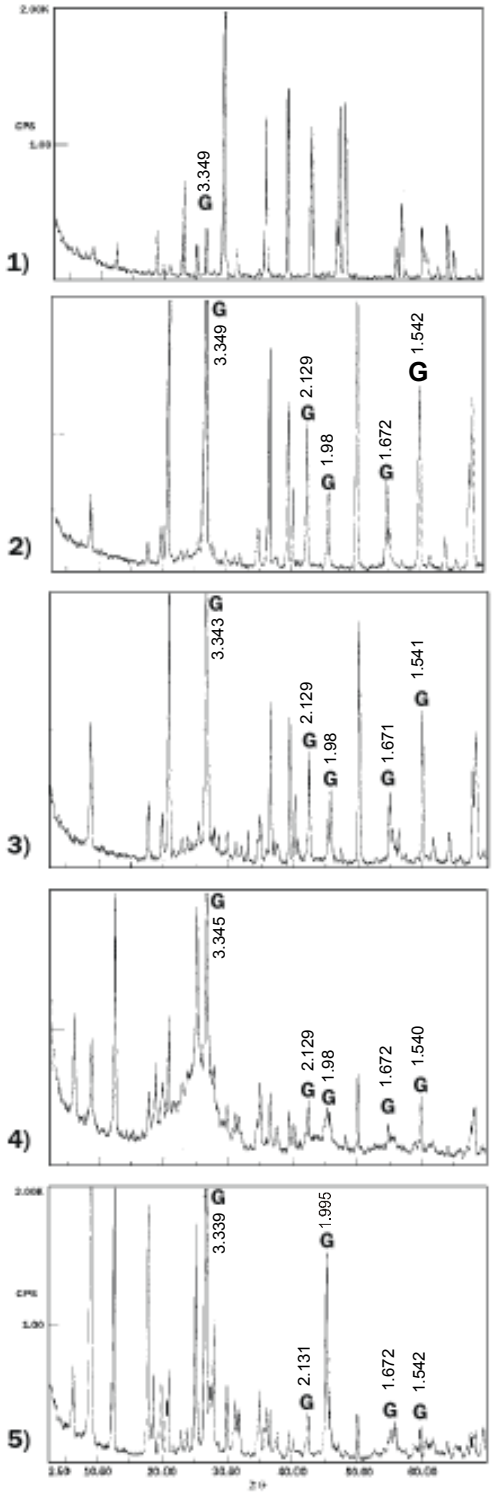

Figure 3. X-ray diffractograms of graphitization material from Tepeköy (1), Tatköy (2, 3) and Meydanköy(4,5).

5. CONCLUSIONS

The graphite occurring as bedded layers in metasedimentary rocks probably resulted from the metamorphism of carbonaceous material of sedimentary origin. Based on X-ray diffraction work and their comparision with metamorphic mineral facies, graphitization began within the chlorite zone of the greenschist facies and was completed prior to the amphibolite facies, that is, at temperatures from ~350 ^{o}C to ~450 ^{o}C and pressure between 3 and 6 Kbar.

6. ACKNOWLEDGEMENTS

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