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NEOTECTONIC ACTIVITY OF ESKİŞEHİR FAULT ZONE IN VICINITY OF İNÖNÜ – DODURGA AREA

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ABSTRACT.-The Eskişehir fault zone which forms the north-northeastern boundary of the Western Anatolian extensional region is situated between the İnegöl fault in the west and the Tuz Gölü fault in the east. Many earthquakes with magnitudes ≥4 have occurred on the Eskişehir fault zone. Of these, the 20 February 1956 Eskişehir (Çukurhisar) earthquake (M=6.4) is the largest event recorded on this fault zone. On the other hand, no remarkable earthquake activity has been recorded in historical and instrumental period on the İnönü – Dodurga segment which is known to be active according to its morphological features and GPS measurements. The İnönü – Dodurga segment is an oblique fault with right-lateral strike-slip component and extends in WNW-ESE and E-W directions along a sharp morphologic lineation. The İnönü – Dodurga fault causes the termination of the NW-SE striking right-lateral strike-slip faults situated to the south of the fault at the boundary of the İnönü basin. Resistivity data show the presence of faults bounding the basin in the north and in the south as well as buried faults. Hanging valleys are situated along the southern margin of the İnönü – Dodurga segment. The earthquake records on the Eskişehir fault zone, geophysical data and the presence of the hanging valleys indicate that the İnönü – Dodurga segment is active and plays an important role in the evolution of the recent morphology.

Key words: Neotectonics, Eskişehir fault zone, İnönü-Dodurga segment, active fault.

INTRODUCTION

The Eskişehir fault zone with a general trend of WNW-ESE extends in between İnegöl in the west and Tuz Gölü in the east and comprised of successive fault segments (Koçyiğit, 2000; Bozkurt, 2001) (Figure 1). This zone, which is defined as Eskişehir fault (McKenzie, 1978; Okay, 1984; Şengör et al., 1985; Barka et al., 1995) has been re-defined as Eskişehir – Bursa fault zone (Şaroğlu et al., 1987) extending in between Uludağ in the west and Kaymaz in the east. The authors have divided the zone into sub-sections such as İnegöl area, İnönü–Dodurga fault zone, Eskişehir fault zone and Kaymaz fault. These sub-sections which are also shown on the Active Fault Map of Turkey (Şaroğlu et al., 1992) have been grouped under the name of Eskişehir fault zone by Altunel and Barka (1998). Some researchers extend and join the fault with the Thrace fault zone which is situated to the northwest Turkey and name it as Thrace-Eskişehir fault zone (Yaltırak et al., 1998; Sakınç et al., 1999; Aksu et al., 2002). Dirik and Erol (2003) state that the Ilıca, Yeniceoba and Cihan-beyli fault zones controlling the western margin of the Tuzgölü basin join with the Eskişehir fault and the authors include them in the Eskişehir–Sultanhanı fault system. The Eskişehir fault zone which is also known as the İnönü–Eskişehir fault zone is reported to extend in between İnegöl and Tuz Gölü (Koçyiğit, 2000; Bozkurt, 2001).

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Eskişehir fault zone extends parallel to the İzmir-Ankara-Erzincan suture zone which plays on an important role in the formation of the tectonic frame of Turkey (Okay, 1984) and has developed on the Anatolide-Tauride platform situated in this zone. Koçyiğit and Kaymakçı (1995) state that WNW-ESE trending İnönü and İnegöl basins that opened along the İzmir-Ankara-Erzincan suture zone continuously overlies the rocks on the northern margin of the Anatolide-Tauride platform and are the relicts of the contractional regime of the İzmir-Ankara-Erzincan suture zone. The authors also state that the basins have been overlain by the latest extensional regime. Kaymakçı (1991), during his study in İnegöl area proposes that the southern boundary of the İnegöl basin is bounded by normal faults with oblique displacements and the extensional direction of the basin is NE-SW.

The Eskişehir fault zone defines the boundary between the strike-slip North Anatolian Fault (NAF) zone and Western Anatolian extensional region which is represented dominantly by normal faults (Barka et al., 1995; Altunel and Barka, 1998) (Figure 1). The Eskişehir fault zone is defined as a right-lateral strike-slip fault with normal component (Şengör et al., 1985; Şaroğlu et al., 1992; Barka et al., 1995; Altunel and Barka, 1998).

Koçyiğit (2003) differentiates two sub-neotectonic regions in Central Anatolia. These are: (1) Konya-Eskişehir neotectonic region, and (2) Kayseri-Sivas neotectonic region. The first region is characterized by tensional neotectonic regime and normal faults with oblique components. The second region, on the other hand, is characterized by a contractional-extensional neotectonic regime and dominant strike-slip faults. One of the structures formed as a result of tensional neotectonic regime that controls the western part of the Central Anatoliais İnönü-Eskişehir fault zone. The initiation age of the neotectonic structures characterizing Central Anatolia is assessed as post-early Pliocene. It is indicated that, depending on the data resulting from the field work, Central Anatolia has been

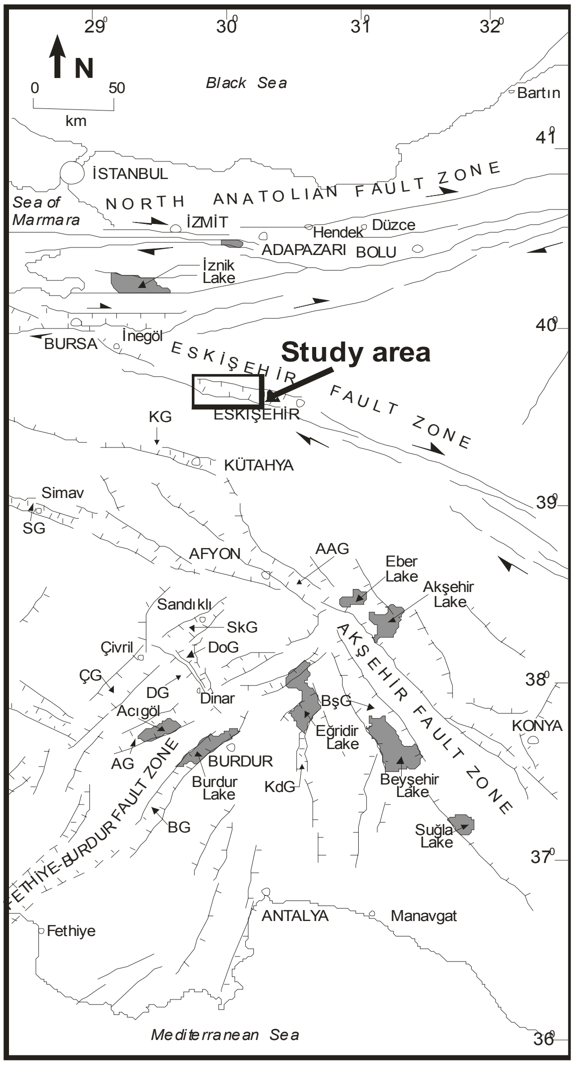

Figure 1- Simplified map showing the main structural elements of the Isparta Angle and its vicinity (after Koçyiğit, 2000 and Bozkurt, 2001). The rectangle shows the study area. Thick lines with half arrows show the strike-slip faults and the sense of movement. Thick lines with ticks denote the normal faults, the ticks are on downthrown side. AG-Acıgöl Graben, BG-Burdur Graben, ÇG-Çivril Graben, DG-Dinar Graben, KG-Kütahya Graben, SG-Simav Graben, AAG-Akşehir-Afyon Graben, BşG-Beyşehir Graben, DoG-Dombayova Graben, KdG-Kovada Graben, SkG-Sandıklı Graben.

deforming at a rate of 2 mm/yr since Middle Pliocene. Eskişehir fault zone, in this study, is defined as a 430 km-long, 15-25 km-wide normal fault with significant right-lateral strike-slip component having oblique displacement. It extends between west of İnegöl in the northwest and Sultanhan in the southeast; its western half strikes WNW-, whereas its eastern half strikes NW.

GPS data indicates that Western-Central Anatolia is characterized by counterclockwise rotation and westward displa-cement. The internal deformation of the inner sections of the Anatolian block is less than 2 mm/yr (Reilinger et al., 1997). The Anatolian block, situated in between two major transform structure, the North Anatolian and East Anatolian Faults moves westward at a rate of 25 mm/yr (Straub, 1996; Straub et al., 1997; Reilinger et al., 1997; Kahle et al., 1998; McClusky et al., 2000) and the lower section of the Anatolian block moves southwestward at a rate of 30 mm/yr (Barka et al., 1995). These data show that (1) the Western Anatolia is divided from Central Anatolia by Fethiye-Burdur and Eskişehir fault zones and moves southwestward, and (2) the rate of westward movement of the Western Anatolia increases from north to south (Barka et al., 1995).

Eskişehir fault zone is one of the important neotectonic structures of our country. The purpose of this study is to reveal the neotectonic features of the Eskişehir fault zone between İnönü and Dodurga. In order to do this, the aerial photographs of the study area were studied, detailed geological and geomorphological investigation along the fault zone were completed, earthquake records of historical and instrumental period were studied and the seismic sections taken in the study area were investigated and the characteristic features of the fault zone were revealed (Tokay, 2001).

STRATIGRAPHY OF THE STUDY AREA

As part of the requirements of the purpose of this research, the characteristics and distributions of the units in vicinity of the Eskişehir fault zone will briefly be presented without going into details.

The basement rocks in the area İnönü marbles (Servais, 1982) and İnönü blueschists (Gözler et al., 1997) belonging to the Tavşanlı Zone (Okay, 1984). Arifler mélange (Küçükayman et al., 1987) and peridotites (Okay, 1984; Gözler et al., 1997) tectonically overlies the basement (Figure 2). To the northeast of the study area, various metamorphic rocks of Sakarya Continent crop out as small windows. The continental Middle-Late Miocene sequence that overlie these rocks with angular unconformity are made up of Porsuk formation (conglomerate, sandstone, claystone, marl, and lacustrine limestones, Gözler et al., 1997) intercalated with Karaköy volcanics (from bottom to top, andesitic, basaltic lava and pyroclastics, Baş et al., 1983). Older and recent alluviums of Quaternary cover the older units unconformably (Figure 2).

Tavşanlı zone

The Tavşanlı zone, which forms the northern-most end of the Anatolide-Tauride platform and is situated to the south of the İzmir-Erzincan suture zone is represented by İnönü marble at the bottom. This unit in the upper levels transits into İnönü blueschists which has undergone low pressure/low temperature metamorphism (Okay, 1984). It is proposed that the depositional age of the rocks of Tavşanlı Zone covers probably most part of the Paleozoic and Mesozoic, and metamorphism took place in Turonian-Lower Cenomanian (Okay, 1984).

İnönü marble (Figure 2) which crop out to the south of İnönü plain, near Kovalca village and in vicinity of Dodurga, is medium to thick bedded,

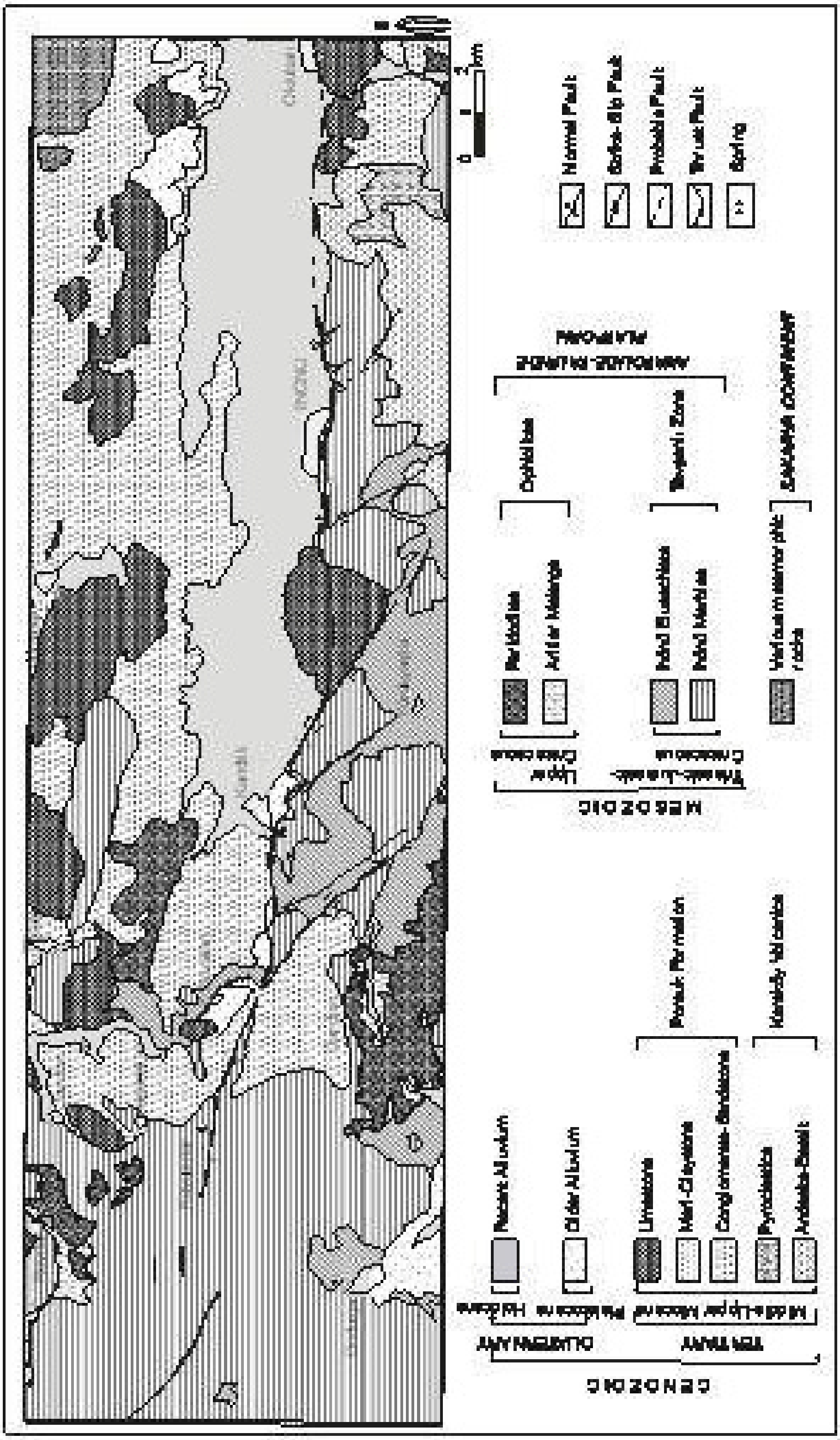

Figure 2- Geological map of İnönü-Dodurga area (compiled after Küçükayman et al., 1987 and Gözler et al., 1997).

white, dirty white, yellowish and light gray colored and is interbedded with schists. Its base in the study area is not observed and its visible thickness is about 200-250 m. İnönü marble is conformably overlain by İnönü blueschists with a sharp contact. This unit crops out to the south of İnönü, between Esnemez and Yürükyayla and to the south of Dodurga (Figure 2). We can uncertainly estimate the thickness of the İnönü blueschists, which are tectonically overlain by ophiolitic rocks, as varying between 700-1000 m. The blueschists are assumed to be of Lower Cretaceous age (Okay, 1984) and in vicinity of Mihalıççık they are dated as 65 and 82 million years by K/Ar method (Çoğulu and Krummenacher, 1967).

Ophiolites

The ophiolites in and around the study area are comprised of mélange and peridotites (Gözler et al., 1997). Dark green, brown and reddish colored mélange is made up of as an tectonic assemblage of radiolarite, mudstone, limestone, metadetritic, diabase, serpentinite, gabbro and metamorphic rocks most probably originated from İnönü blueschists. The visible thickness of ophiolites in the study area reachs up to 100 to 150 m, locally.

A 90% of peridotites observed as huge masses are made up of harzburgites and dunites (Okay, 1984; Gözler et al., 1997). Peridotites in the study area are widespread around south of İnönü, Esnemez, Darıdere and Çokçapınar villages. Listwaenites which are observed mostly in tectonic zones and at the upper levels of peridotites are yellowish brown and dirty yellow colored; they are readily distinguishable from a distance by their color and sharp morphologies.

The age of the unit is end of Maastrichtian-beginning of Eocene (Küçükayman et al., 1987).

Porsuk formation

Fluvial and lacustrine deposits comprised of conglomerate, sandstone, claystone, marl and lacustrine limestones were differentiated as Porsuk formation (Gözler et al., 1997).

Conglomerates and sandstones are quite widespread in the study area; they mostly crop out east of Çaydere, Kapanalan, Bozalan villages and in vicinity of Akpınar village (Figure 2). The color of the formation, dark red, brown, yellow, gray, greenish gray, varies depending on the color and type of rock from which the material was taken. There are sandstone bands in conglomerates, they are laterally and vertically transitive with each other. Generally, above the conglomerates, at the lower levels of the limestone, rather thin, green, yellow colored marl-claystone interbeds are observed. Thin bands of limestones can be observed between marl and claystone. Basaltic flows between the formation and the overlain conglomerate and sandstones can also be observed (Gözler et al., 1997). The white, gray, yellowish beige colored lacustrine limestones have medium thickness and they display well bedding. The formation is rather well preserved at the hilltops, and includes rare chert bands. It is mostly porous and locally silicified.

The approximate thickness of the Porsuk formation varies between 100 to 300 m. No datable fossils were detected in the formation, however, depending on the regional correlation it is assumed to be of Middle-Late Miocene age (Gözler et al., 1997).

Karaköy volcanics

This unit typically crops put to the south and southeast of İnönü town, it is represented by andesitic lavas and pyroclastics. At the bottom of the unit, generally there is a 1-10 m thick conglomerate and sandstone. Its thickness varies between 50 to 100 m. Pyroclastics are represented by agglomerates with tuffaceous interbeds. The gray, dark gray colored agglomerates have generally formed by cementing of middle size volcanic rock particles in tuffaceous matrix. Andesitic-basaltic lavas are gray, dark gray colored and display flow structures locally, their upper levels are porous. Servais (1982) dated the unit as 14.2 my (Middle Miocene) using K/Ar method.

Quaternary

Quaternary is divided into two as older and new alluviums in the study area, it is represented generally along the streams and in between the ridges. The unit includes pebbles and blocks of the basement rocks; it does not display grading and sorting.

The older alluviums are made up of blocks, pebbles and sands of the pre-Quaternary lithologies and of mud and silt. Their color varies depending on the material included. Locally the unit displays cross-bedding, and it is low consolidated and thick bedded. It unconformably rests on the basement rocks and Middle-Upper Miocene rocks and is overlain by new alluvium. The age of the unit, depending on the vertebrate fossils found inside the clayey levels, is Early Pliestocene (Willafranchian) (Gözler et al., 1984).

The new alluvium is comprised of material such as unconsolidated pebbles, sand, silt and clay transported by Sarısu stream and by the other streams.

ESKİŞEHİR FAULT ZONE BETWEEN İNÖNÜ AND DODURGA

The general WNW-ESE trend of the Eskişehir fault zone changes in between E-W and WNW-ESE between İnönü – Dodurga. The 33 km-long section of the fault lying in between north of Dodurga and Oklubalı village was differentiated as İnönü-Dodurga segment (Tokay, 2001; Tokay and Altunel, 2001) (Figure 3). We made observations and made us of geophysical data in order to determine the features on the activity of the İnönü – Dodurga segment.

Geological observations

The İnönü – Dodurga segment extending to the south of the İnönü basin lies in E-W direction in between north of İnönü and Oklubalı village, however, in vicinity of Kandilli and to the west of Kandilli its direction changes into WNW-ESE (Figure 3). The fault forms the contact between the debris flow, alluviums and Mesozoic marbles. The debris flow covering the fault plane has provided protection of the various structural features, by removal of the debris flow for some reason, in some sections, the fault plane has become visible (Figure 4). The fault plane strikes generally N70-80W and dips 70° NE and 90°. The fault breccia is observed where the fault plane is well preserved. The striations on the fault plane indicate vertical and oblique movement of the fault. The striations with deviation angles dipping 52° NE indicate the existence of the oblique movement on the fault plane (Figure 5). The fault lying in approximately NW-SE direction again forms the contact in between the Mesozoic marbles and Quaternary deposits to the south of Kandilli village, on the fault plane in this region, on the fault plane which strikes N70W and dips 77° NE fault striations dipping 44° NE support the oblique movement of the fault. On the fault planes south of Kandilli village the fault gouge are quite prominent.

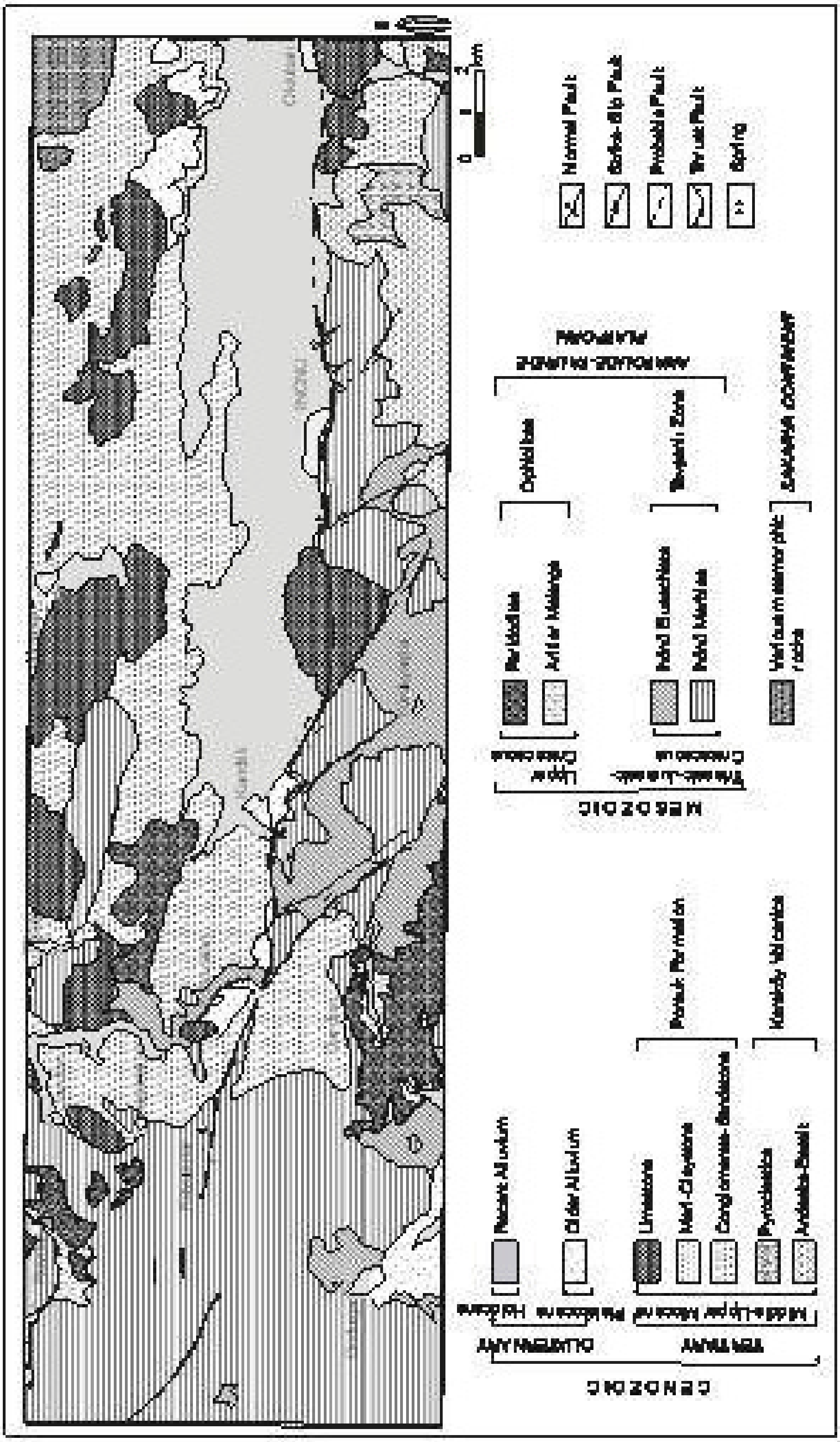

Figure 3- Faults of neotectonic period on topographic map of area. Contours are at every 50 m.

Figure 4- Fault plane as observed by the removal of slope debris, south of İnönü.

Figure 5- Fault striations showing the oblique offset (the geologist pick and the arrows are parallel to the striations).

To the east of İnönü, in Middle-Upper Miocene deposits that form a contact with Mesozoic marbles, there are synthetic and antithetic fault lying in E-W direction parallel to the main fault plane. In Middle-Upper Miocene limestones and in the overlain claystones, synthetic faults that developed towards İnönü basin are observed. On the other hand, to the south and southwest of Oklubalı village, along the contact between Quaternary deposits covering the base of the İnönü basin and the Middle-Upper Miocene rocks, the fault can not be observed barely. However, the E-W trending drastic topographic relief difference between the heights in the south and the base of the basin is a result of the stepping fault observed in the alluvium fan. The E-W trending morphologic stepping observed to the west of İnönü is also a result of the movement of this fault.

The fault situated in the Mesozoic marbles west of the study area displays a topographic difference with a vertical offset of 200 m. The fault planes on the N60-86W striking and 60-85^0 NE dipping fault have been eroded. On the downthrown block of this fault two antithetic N78W striking faults are seen, the northern blocks of these two faults are uplifted about 2 m.

When we look at the İnönü-Dodurga segment in general, at the back of the main fault-plane at the downthrown block, we see overstepping faults upwards, and fault planes with different dip angles. The directions of these faults that developed related to the activity of the İnönü-Dodurga fault are parallel to each other.

There are also roughly parallel and NW trending faults in the study area (Figure 3). The planes of these faults which are observed especially in between south of Kandilli and Yürükyayla strike N35-50W and dips 70° NE and 90°. The striations and notches which are barely visible and parallel to the strike on the fault planes indicate the right-lateral sense of the faults (Figure 6). No evidence on vertical and/or oblique movement of the fault was found on the fault planes. On the faulted surfaces approximately 2 cm-thick, bright, waxy fault gouge has formed due to shearing. The northern ends of these right-lateral strike-slip faults that extend subparallel to each other are terminated in the İnönü basin, in İnönü-Dodurga segment. To the north of the basin no evidence about these right-lateral strike-slip faults are observed. In the study area, where the right-lateral strike-slip faults and the İnönü-Dodurga segment are intersected there are two hot water springs. These are situated to the east and west of İnönü (Figure 3).

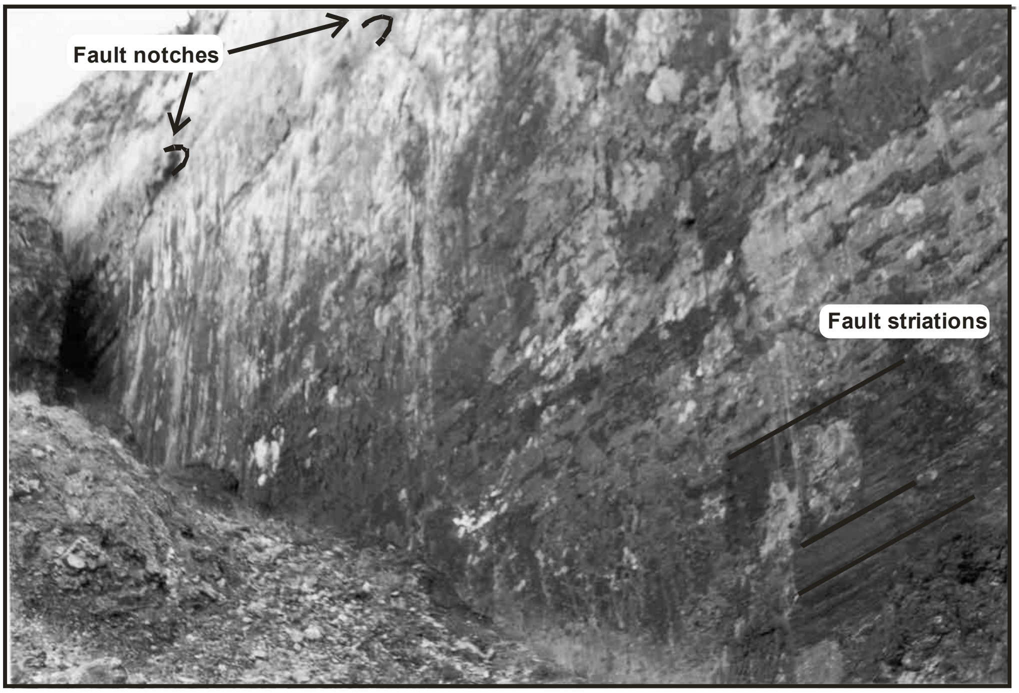

Figure 6- Fault striations developed parallel to the strike of the strike-slip fault, south of İnönü.

Geomorphological and Morphotectonic Observations

In vicinity of İnönü (Figure 3) there is a high plateau system bearing the imprints of the paleotectonic period. These plateaus which are of erosive origin have developed on a range of formations of Triassic to Upper Miocene age and possibly are of Pliocene age. To the south of the Kuyupınar-İnönü-Oklubalı line this erosive surface has been uplifted, however, it is situated at rather lower levels to the southwestern and northern sections of the study area. It abruptly terminates at Kuyupınar-Oklubalı line. To the north of this line there is a Quaternary depocenter lying parallel to the line. Especially southern border of this E-W trending depositional basin is fault-controlled. E-W running Sarısu stream cuts the İnönü basin which is situated at north of the fault. Besides, the southern tributaries of the Sarısu stream which drains and runs perpendicular to the fault joins to the E-W running main stream. The valleys which are formed by the tributaries are young and younging heads at the downthrown block are very prominent. There are intensive mass movements at the slopes of the valleys. The tributaries of the Sarısu stream have emplaced onto the buried meanders on the southern block of the İnönü-Dodurga segment. These valley forms have shaped related to the uplift of the downthrown block of the fault. Near Kandilli, although the drainage area is wide and the load of the tributary is too much where the slope angle decreased, the expected formation of the fan has not been provided.

In the marbles cropping out at the fault scarps developed along the Kuyupınar-Oklubalı line hanging underground karstic drainage systems (caves) are very prominent. Here, the height of the hanging valleys from the base of the basin reaches up to 70 m (Figure 7). At the hanging valleys which their amount increases to the south of İnönü the heads of younging are quite apparent.

At the northern section of the study area the slopes are gentle and the transition to the base of the basins is not as abrupt as they are in the south. The Pliocene aged erosional surfaces have been overlain by Quaternary deposits. Northeast of the study area has in part by blocking and in part by tilting towards SE been uplifted.

At present, the İnönü basin that has been drained by Sarısu stream displays an asymmetric sink morphology approximately trending in E-W direction. In the general geomorphologic structure observed in the south of the basin southward tilting is quite prominent and they have most probably occurred on the upthrown block of the İnönü-Dodurga segment (Figure 3).

Figure 7- Hanging valleys developed on the downthrown block of the fault (the arrows show the valleys).

Geophysical data

In this section gravity, aeromagnetic and resistivity data prepared for different reasons by General Directorate and State Hydraulic Works have been re-evaluated.

Gravity contour maps have been useful in differentiating alluviums and younger rocks represented by low density from those rocks with high density. According to gravity contour maps, the İnönü basin is situated where the basement rocks are deepseated and the young deposits are thicker. The abrupt changes observed to the north and south of the basin indicate that the basin might be bounded by faults. The sharp changes in the magnetic magnitude at the aeromagnetic contour anomalies observed to the north and the south of the basin verify the gravity data for the presence of the ground checked faults.

According to five north-south trending resistivity profiling studies in the İnönü basin 30 to 100 m-thick pebblestones overlie the basement rocks. This unit is covered by sandstone, claystone, pebblestone and marls of varying thicknesses and successions. The total thickness of these units varies between 100-250 m. The thickness of the alluvium in the plain is 40 m (Mumcu, 1975). The resistivity data, on the other hand, enable us to interprete the presence of two east-west trending faults running in between Kandilli in the west and Oklubalı village in the east (Figure 8 a, b). Of these the northerly situated fault is buried. According to resistivity sections, the İnönü basin has the appearance of a graben bounded by faults in the south and in the north.

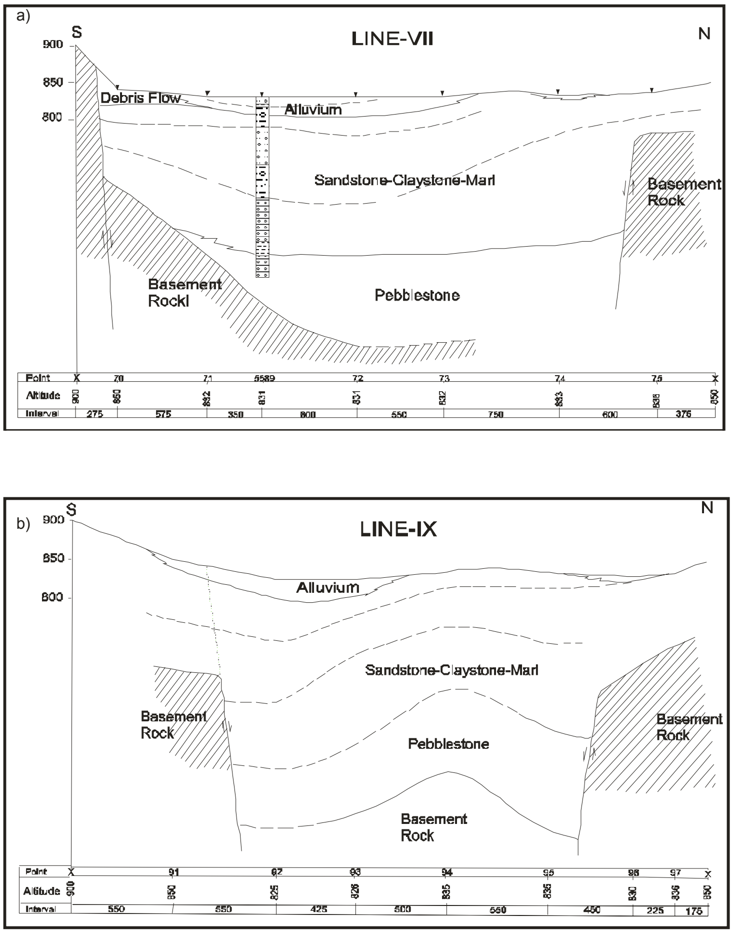

Figure 8- Resistivity cross-sections acquired in the İnönü basin. a) Line-VII, electric structural section, b) Line-IX, electric structural section (Mumcu, 1975).

SEISMICITY

The faults that characterize the Central Anatolia region have the capacity to produce large earthquakes at every 1000-2000 years and, middle and small-sized earthquakes have the same capacity at every 10-30 years (Koçyiğit, 2003). The Eskişehir fault zone is situated in between the North Anatolian fault zone (a first degree earthquake zone) and Aegean region. The faults that form the Eskişehir fault zone are mostly active and have the capacity of producing small to medium-sized earthquakes. Historical records reveal the Beylikahır (Eskişehir) earthquake (magnitude V) east of Eskişehir (39.75N – 31.10E) (Soysal et al., 1981) which is considered to occur as a result of the movement of Eskişehir fault zone by Koçyiğit (2003). During the instrumental period in the 20th century, in the area between Eskişehir and Bursa (39.5-40.3N and 29.0-31.0E) 53 M≥4 earthquakes have occurred. The epicentral distribution of these earthquakes displays a disregardable seismic activity in the area. The largest earthquake recorded on the Eskişehir fault zone is February 20, 1956 Eskişehir earthquake. The epicenter of the event is situated near Çukurhisar to the 10 km west of Eskişehir (Öcal, 1959). The focal mechanism solution of the earthquake indicates movement of a normal fault with strike-slip component (McKenzie, 1972).

According to GPS measurements the rate of internal deformation of the Central Anatolia is less than 2 mm/yr (Reilinger et al., 1997). Altunel and Barka (1998), evaluating the historical and instrumental data together with GPS data, propose that the rate of motion along the Eskişehir fault zone is approximately 1-2 mm/yr. On the other hand, Koçyiğit et al. (2003) reports the normal rate of movement of the Eskişehir fault as 0.07-0.13 mm/yr depending on their field observations.

DISCUSSION AND RESULTS

The neotectonic features of the İnönü-Dodurga segment of the Eskişehir fault zone have been studied from geological and geomorphological point of view, by making use of geophysical data and GPS measurements. The data obtained from this research are conformable with each other and show that the fault lies in E-W direction to the south of the basin, on the other hand, west of Kandilli it is observed in WNW-ESE direction. Geomorphological and geophysical data indicate the presence of E-W trending antithetic faults bounding the basin in the north.

Eskişehir fault zone displays fault striations dipping 52^0 and 44^0 NE on the fault planes. This data verifies that the fault is an oblique fault with right-lateral strike-slip component. The general trend of the fault is WNW, however, along the fault, the widening direction is NNE-SSW.

The northern tips of the right lateral strike-slip parallel faults lying in NW-SE direction to the south of the İnönü basin are being cut by the İnönü-Dodurga segment which implies the latter is younger than the first fault set. Also, where these faults intersect, to the west and east of İnönü there are hot water springs; the spots where these hot waters ascend to ground surface are the knots of the tectonic structures (Altunel and Hancock, 1993). The presence of the springs are most possibly related to the activity of the İnönü-Dodurga fault.

The presence of the fault planes at various dipping angles that are present to the back of the main fault plane as steps and the stepping structure observed at the hanging valleys are the common morphological structures observed on the surface of the active normal fault surfaces. These structures also indicate that, in order to form the İnönü-Dodurga scarp, the faults must have moved more than one time.

Morphotectonic observations, on the other hand, have revealed that the fan formed in Pliocene was disrupted by an E-W trending fault, resulting in a depositional area parallel to the fault. It can be said that, while the Pliocene erosional surface situated to the south of Dodurga, Darıdere, Yürükyayla and Oklubalı is cut by İnönü-Dodurga segment, in the above-mentioned villages the surface has been uplifted in blocks.

The young topography observed along the İnönü-Dodurga segment, the stepping to the back of the main fault plane, hanging valleys, hot water springs and the earthquakes occurred in the instrumental period along the Eskişehir fault zone indicate that the fault zone is active at present.

The low rate of deformation along the Eskişehir fault may be a reason for the wide recurrence interval of big earthquakes. The Eskişehir fault zone is made up of successive segments and these segments may be activated in different time frames. Although there are no significant earthquakes along the İnönü-Dodurga segment in historical and instrumental periods, when we consider to the wide recurrence interval and the rather significant magnitude of the Eskişehir (Çukurhisar) earthquake (M=6.4) we can say that the İnönü-Dodurga segment has the capacity to produce earthquakes.

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ORIENTATION OF THE ANDESITIC DYKES IN THE İSTANBUL REGION: AN APPROACH TO THE CRETACEOUS STRESS DISTRIBUTION

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ABSTRACT.- For dykes in the upper crust, the strike of the dyke is parallel to the σ_1-σ_2 plane, and the normal to the dyke is aligned with the least compressive stress σ_3. This relation enables the determination of the palaeo-stress distribution from the orientation of the dykes. In order to estimate the stress distribution in the Late Cretaceous in the Istanbul region, the orientation of the dykes in the Paleozoic sedimentary rocks have been measured. The dykes consist of andesite and basaltic andesite, and form massif, highly fractured pale yellow, beige and grey rocks. Their thickness ranges from 10-20 cm to 10-11 m and their length generally is measured in several tens of metres. Petrographically the dykes show a porphyritic texture with plagioclase, hornblende and augite phenocrystalls, 1.5-3.5 mm across, in a fine grained microlithic matrix. The measured strikes of the dykes show a wide scatter with a few prominent directions (N80°E, N40°E and N35°W). The wide scatter in the dyke direction suggests that the Istanbul dykes form a local dyke swarm above an unexposed pluton. Another possibility is that the Istanbul dykes were emplaced in a complex stress regime controlled by the opening of the oceanic West Black Sea basin and activity of the West Black Sea fault.

Key words: Black Sea, dykes, Istanbul, Cretaceous, andesite, stress.

INTRODUCTION

Presence of dykes, sills and small intrusions cutting the Palaeozoic sedimentary rocks in the Istanbul region is known since the 19th Century. These andesitic hypabyssal rocks, which are generally considered to be of Cretaceous age, are mentioned in many regional geological studies (Paeckelmann, 1925; Okay, 1947, 1948; Erguvanlı, 1949; Ketin, 1959) and their distribution is shown schematically in some geological maps of the Istanbul region (Paeckelmann, 1938; Sayar, 1949). However, there is no systematic information on the orientation of these andesitic dykes and sills. Such data will provide information on the stress field in the Istanbul region during the Cretaceous, as explained below. In this study we provide information on the orientation of dykes in the Istanbul region in attempt to estimate the orientation of the stress axis during the Cretaceous.

Theoretical and empirical studies have shown a close relation between the orientation of the principal stress axis in the crust and the orientation of a dyke (Anderson 1936, 1972; Pollard, 1987; Marinoni, 2000; Ramsay and Lisley, 2000). The strike of the dyke is parallel to the σ_1-σ_2 plane during the injection of the dyke, and the normal to the dyke represents the minimum compressive principal stress σ_3. Just prior to the emplacement of the dyke a tiny crack forms in the crust, perpendicular to the prevailing σ_3, and the dyke follows this crack upwards enlarging and thickening it (Anderson, 1936, 1972; Hills, 1963).

Dykes in the continental crust are generally found in swarms. The dyke swarms can be divided into regional and local swarms. The regional dyke swarms consist of hundreds to thousands of subparallel dykes, which can be followed for hundreds of kilometres. A typical

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example of a regional dyke swarm is that found in northwestern Britain, which forms a Tertiary swarm made up of thousands of dykes striking northwest-southeast (Richey, 1939; Hills, 1963; Johnstone, 1966). This Tertiary dyke swarm is related to the rifting and opening of the Northern Atlantic oceans. In contrast to the regional dyke swarms, local dyke swarms form around plutonic bodies and have lengths measured in tens of kilometers. In the local dyke swarms, the strike of the dykes generally shows a radial distribution, with individual dykes striking perpendicular to the margins of the pluton. The radial dyke swarms around the plutons in the interior of USA constitute typical examples for local dyke swarms (Parsons, 1939; Johnson, 1961; Hills, 1963).

The İstanbul region is located on the southwestern corner of the Black Sea, which is considered a back-arc basin opened during the Cretaceous behind the Pontide magmatic arc (Letouzey et al., 1977; Tugolesov et al., 1985; Görür, 1988; Finetti et al., 1988; Okay et al., 1994). The Black Sea consists of two oceanic basins, called the West and East Black Sea basins, separated by the Mid Black Sea ridge (Figure 1). The West Black Sea basin comprises a Cretaceous to Recent sedimentary sequence, over 15 km thick, deposited on oceanic crust. The thick sedimentary cover in the West Black Sea basin disguises the magnetic anomalies that must be present in the underlying oceanic crust. Therefore, there is no information on the orientation of the oceanic ridge in the West Black Sea basin and hence on the distribution of the principal stresses during the opening of the Black Sea. The mid-ocean ridges strike parallel to the σ_1-σ_2 plane and are perpendicular to σ_3 direction. Therefore, it is hoped that a systematic determination of the orientation of the dykes in the Istanbul region would also provide information on the direction of opening of the West Black Sea basin.

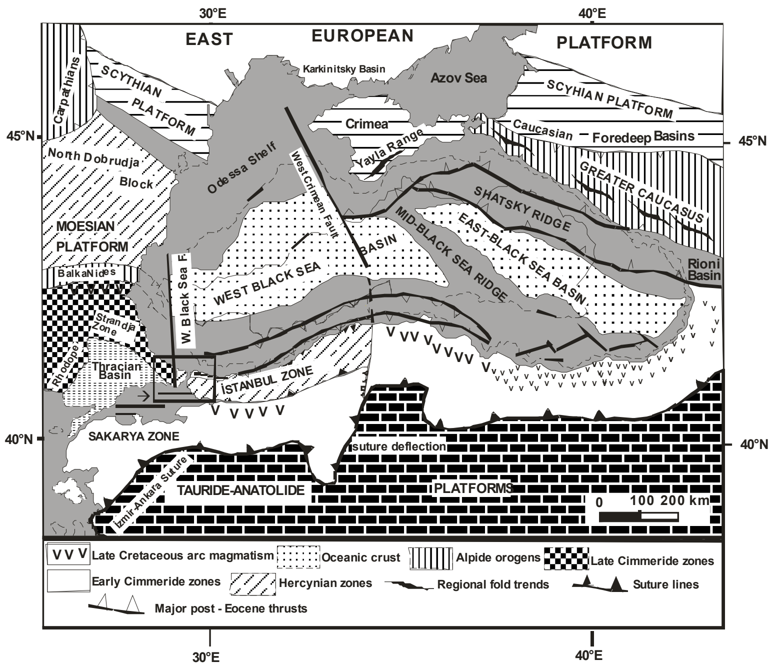

Figure 1- Tectonic map of the Black Sea region showing the setting of the Istanbul region (modified after Okay et al., 1994)

THE GEOLOGICAL SETTING OF THE CRETACEOUS HYPABYSSAL ROCKS IN THE İSTANBUL REGION

A transgressive sedimentary sequence of Ordovician to Carboniferous age crops out on both sides of the İstanbul strait (Paeckelmann, 1938; Kaya, 1973; Görür et al., 1997). This sequence, consisting of sandstone, quartzite, conglomerate, shale, limestone and chert is thrust northward over the Upper Cretaceous volcano-sedimentary rocks (Figure 2). In the east, Triassic conglomerate and sandstone lie unconformably over the Palaeozoic rocks. The Triassic sequence is in turn overlain unconformably by the Upper Cretaceous (Maastrichtian) limestones and cherts (Özer et al., 1990). All these units are overlain unconformably by the Eocene and younger sequences (Figure 2).

The Palaeozoic rocks in the İstanbul region are cut by numerous andesitic dykes and sills. Although there is no published isotopic data on the age of these rocks, all the studies including this one, regard the age of these hypabyssal rocks as Cretaceous. There are three indirect lines of evidence for the Cretaceous age of the andesitic hypabyssal rocks in the Istanbul region.

- There are no volcanic intercalations in the İstanbul Palaeozoic sequence. Similarly, volcanic rocks are absent in the overlying Triassic sequence, with the exception of some basaltic lava flows in the basal part of the Triassic series. As discussed in the next section, andesitic volcanic rocks are present in the Cretaceous sequence in the northern parts of Istanbul. However, magmatic rocks are again lacking in the Eocene and younger series around Istanbul, which are unconformably over all the older rocks. These stratigraphic observations bracket the age of the Istanbul andesitic dykes, which cut the Palaeozoic rocks, between Triassic and Eocene.

- A volcano-sedimentary sequence of Cretaceous age has been mapped between Şile and Kilyos on both sides of the İstanbul strait north of Istanbul (Baykal, 1943; Yeniyol and Ercan, 1990). This series, which constitutes part of the Pontide magmatic arc, consist of agglomerate, tuff, sandstone and siltstone, which are intercalated with andesitic lavas. A genetic connection is expected between these andesitic lavas north of Bosphorus, and the andesitic dykes cutting the Palaeozoic sedimentary rocks.

- A granitoidic pluton, with a diameter of 4.5 km, crops out on the Anatolian side of the Bosphorus east of Beykoz (Figure 2). This pluton, known as the Çavuşbaşı granitoid, cuts the Ordovician arkosic sandstones (Ketin, 1941; Okay, 1947), and its age is determined by Rb/Sr biotite method as 65 ± 10 Ma (Öztunalı and Satır, 1975). The andesitic dykes in the İstanbul region can be plausibly linked tothe same magmatic cycle, that generated the Çavuşbaşı pluton.

The three indirect lines of evidence, cited above, strongly suggest that the andesitic dykes in the Istanbul region, which cut the Palaeozoic rocks, are Late Cretaceous in age. These hypabyssal rocks, together with the Upper Cretaceous volcano-sedimentary sequence north of Istanbul, form part of the Pontide magmatic arc, which formed above the northward subducting Neo-Tethyan ocean (Şengör and Yılmaz, 1981; Okay and Tüysüz, 1999).

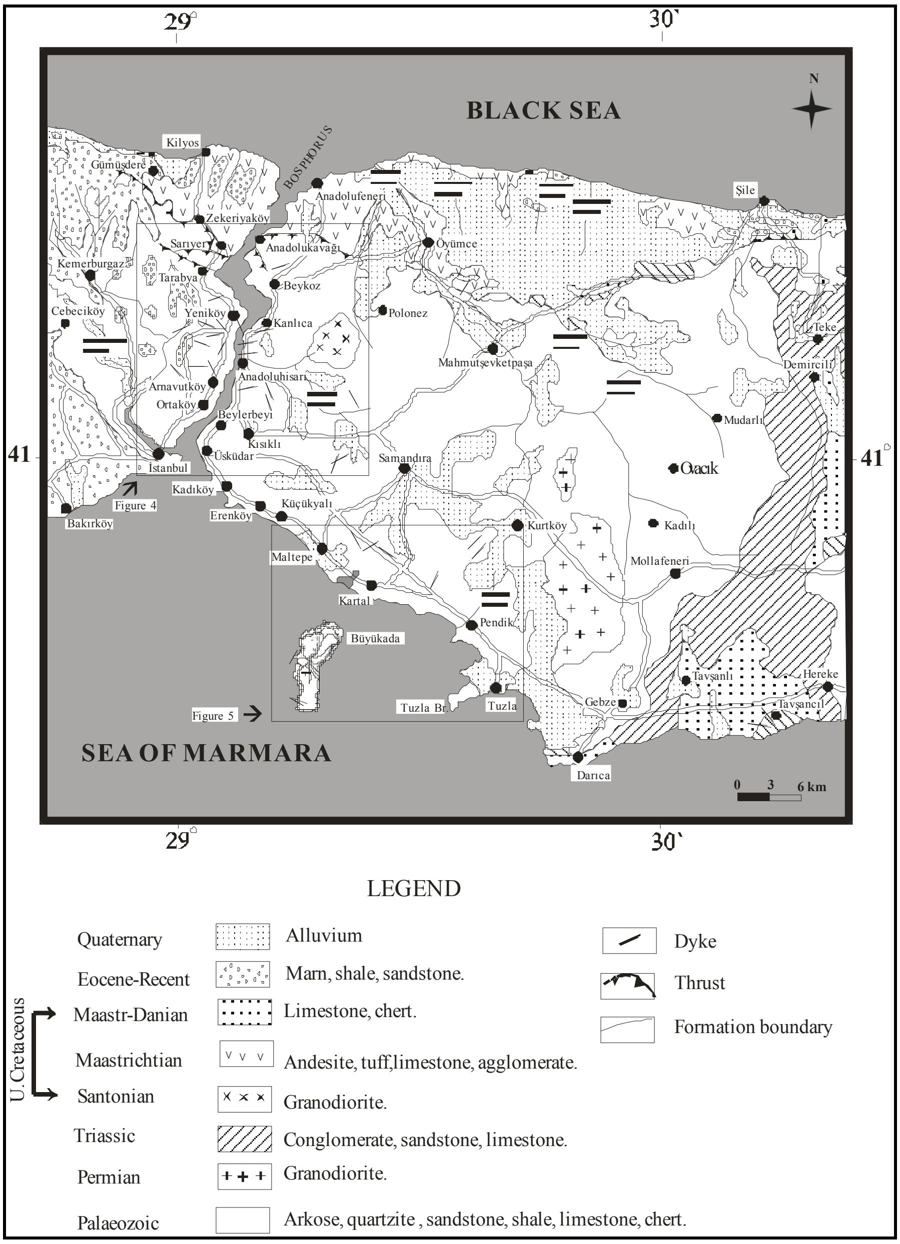

Figure 2- The geological map of the İstanbul region with the dyke locations (modified from Türkecan and Yurtsever, 2002)

CRETACEOUS DYKES IN THE İSTANBUL REGION

A large area on both sides of the İstanbul strait has been systematically searched for the presence of dykes. Outcrops are very rare in this region, which is densely urbanized and build-up. Furthermore, many of the andesites in this region form minor intrusions of irregular shape. The geometry of such intrusions is not useful in obtaining the paleo-stress distribution. The best structures for obtaining the paleo-stress distribution are subvertical dykes, as shown in figure 3, in which both margins are readly observed.In the İstanbul region thirty two of such dykes are found and described. The geographic coordinates of these dykes, as measured by GPS, their strikes and dips, and geographic locations are given in table 1 and their distribution is shown in figure 3 and figure 4.

Table 1- The location and geometric features of the studied dykes in the Istanbul region.

OBSERVATION MUMBER	LOCATION	GPS VALUE	STRIKE AND DIP DIRECTION	THICKNESS AND LENGTH
1	Tarabya	N:41° 08,07' E:29° 02,97	70 / 90 ☻☻☻	T: 4,0 m. L: 13,0 m. (min.)
2	Ayazağa	N:41° 07,37' E:28° 59,80'	80 / 90 ☻☻☻	T: 1.5 m. L: 5,0 m. (min.)
3	İstinye	N:41° 07,56' E:29° 02,23'	115 / 90 ☻☻☻	T: 2.7 m. L: 6,0 m. (min.)
4	Emirgan	N:41° 06,69' E:29° 03,37'	155 / 90 ☻☻	T: 1.5 m. L: 7,0 m. (min.)
5	Poligon	N:41° 06,69' E:29° 02,43'	140 / 90 ☻☻	T: 1.5 m. L: 50 cm. (min.)
6	I.T.U Cam.	N:41° 06,06' E:29° 01,31'	80 / 90 ☻☻☻	T: 70 cm. L: 5,0 m. (min.)
7	I.T.U Cam.	N:41° 05,90' E:29° 01,63'	80 / 90 ☻☻☻	T: 2,0 m. L: 20,0 m. (min.)
8	I.T.U Cam.	N:41° 05,94' E:29° 01,00'	110 / 90 ☻☻☻	T: 3,0 m. L: 8,0 m. (min.)
9	Baltalimanı	N:41° 05,91' E:29° 02,96'	90 / 75 N ☻☻☻	T: 2,0 m. (min.) L: 4,0 m. (min.)
10	Baltalimanı	N:41° 05,59' E:29° 03,29'	30 / 82 NW ☻☻☻	T: 1.5 m L: 15,0 m. (min.)
11	B.Bebek	N:41° 04,39' E:29° 02,67'	35 / 88 SE ☻☻	T: 1,0 m. L: 4,0 m. (min.)
12	B.Bebek	N:41° 04,39' E:29° 02,67'	35 / 90 ☻☻	T: 60 cm. L: 4,0 m. (min.)
13	Çamlıbahçe	N:41° 04,19' E:29° 02,71'	150 / 60 ☻☻☻	T: 1,5 m. (min.) L: 2,0 m. (min.)
14	Çamlıbahçe	N:41° 04,19' E:29° 02,71'	60 / 90 ☻☻☻	T: 60 cm. L: 10,0 m. (min.)
15	Arnavutköy	N:41° 04,18' E:29° 02,68'	92 / 80 N ☻☻☻	T: 1,0 m. L: 2.5 m. (min.)
16	Ulus	N:41° 03,91' E:29° 01,64'	140 / 90 ☻☻☻	T: 1,0 m. L: 3,0 m. (min.)
17	Yalıköy	N:41° 08,87' E:29° 05,95'	75 / 82 SE ☻☻	T:1,0 m. L:2,0 m. (min.)

Table 1- Continue

OBSERVATION MUMBER	LOCATION	GPS VALUE	STRIKE AND DIP DIRECTION	THICKNESS AND LENGTH
18	Zerzevatçı	N:41° 06,86' E:29° 09,47'	40 / 90 ☻☻	T:1,0 m. L:3,0 m. (min.)
19	Kanlıca	N:41° 05,84' E:29° 03,85'	80 / 90 ☻☻	T:1,8 m. L:8,0 m. (min.)
20	Kanlıca	N:41° 05,84' E:29° 03,89'	90 / 90 ☻☻☻	T:40 cm. L:3,0 m. (min.)
21	Kanlıca	N:41° 05,84' E:29° 03,89'	80 / 90 ☻☻☻	T:1,0 m. L:10,0 m. (min.)
22	Anadoluhisarı	N:41° 05,44' E:29° 04,02'	85 / 90 ☻☻	T:1,0 m. L:3,0 m. (min.)
23	Vaniköy	N:41° 03,74' E:29° 03,24'	75 / 65 NW ☻☻	T:4,0 m. L:10,0 m. (min.)
24	Üsküdar	N:41° 03,35' E:29° 04,71'	160 / 90 ☻☻	T:10,0 m. (min.) L:2,5 m. (min.)
25	Üsküdar	N:41° 03,33' E:29° 04,05'	165 / 90 ☻☻☻	T:1,5 m. L:3,0 m. (min.)
26	Çekmeköy	N:41° 02,22' E:29° 10,40'	150 / 90 ☻☻☻	T:2,0 m. L:4,0 m. (min.)
27	Dudullu	N:41° 00,57' E:29° 09,38'	20 / 90 ☻☻☻	T:1,5 m. L:4,0 m. (min.)
28	Dudullu	N:41° 00,57' E:29° 09,38'	65 / 90 ☻☻☻	T:60 cm. L:4,0 m. (min.)
29	Maltepe	N:40° 56,33' E:29° 08,14'	150 / 90 ☻☻☻	T:2,0 m. L:3,0 m. (min.)
30	Maltepe	N:40° 56,33' E:29° 08,14'	60 / 65 NW ☻☻☻	T:3,0 m. L:6,0 m. (min.)
31	Maltepe	N:40° 55,87' E:29° 08,67'	120 / 65 NE ☻☻☻	T:5,0 m. (min.) L:12,0 m. (min.)
32	Kurtköy	N:40° 55,35' E:29° 17,86'	43 / 90 ☻☻☻	T:6,0 m. L:2,5 m. (min.)
33	Kurtköy	N:40° 55,35' E:29° 17,86'	45 / 90 ☻☻☻	T:3,5 m. L:2,5 m. (min.)
34	Pendik	N:40° 52,86' E:29° 15,01'	25 / 80 SE ☻☻☻	T:5,0 m. L:1,0 m. (min.)
35	Tavşancıl	N:40° 46,22' E:29° 34,16'	100 / 80 NE ☻☻	T:1,5 m. L:5,0 m. (min.)
36	Tavşancıl	N:40° 46,22' E:29° 34,16'	140 / 90 ☻☻	T:8,0 m. L:10,0 m. (min.)
37	Cape of Dil Büyükada	N:40° 51,67' E:29° 06,80'	32/ 75 NW ☻☻	T: 2,5 m. L: 20,0 m. (min.)
38	Cape of Ayine Büyükada	N:40° 49,20' E:29° 06,60'	120 / 76 NE ☻☻☻	T: 1.5 m. L: 15,0 m. (min.)
39	Cape of Ayine Büyükada	N:40° 49,20' E:29° 06,60'	105 / 90 NE ☻☻☻	T: 2.0 m. L: 10,0 m. (min.)

☻☻☻ Dyke contact zone with host rock best defined.
☻☻ Dyke contact zone with host rock moderately defined

Most of the 39 dykes, where the strikes and dips are measured unambiguosly, are located on both sides of the İstanbul strait (Figure 3). The concentration of the andesitic hybyssal rocks on both sides of the İstanbul strait and their relative scarcity farther inland can also be seen in the geological map of Sayar (1949). Apart from the vicinity of İstanbul strait, dykes have been located on the E5 highway between Küçükyalı and Pendik cutting the Palaeozoic rocks (Figure 4), and in the Gebze-Tavşancıl region cutting the Triassic sediments.

The dykes in the İstanbul region form highly fractured, massive yellow, beige and green rocks (Figure 5). Locally cataclasis is observed along the contacts of the dykes with the surrounding sedimentary rocks. The thickness of the dykes ranges from 10-20 cm to 10-11 m (Figure 6). The dykes cannot be followed long distances along thje strike; generally they are lost after a few tens of metres either because of lack of outcrops or because of deformation.

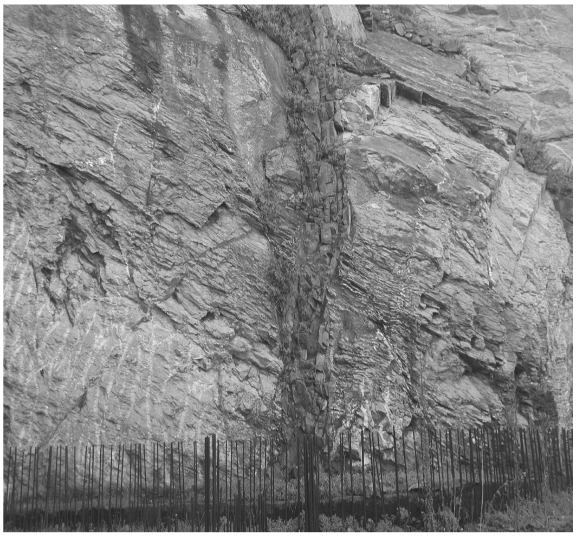

Figure 3- An example of a dyke from the European coast of İstanbul cutting the Devonian limestones. The thickness of the dyke is 60 cm (This dyke corresponds to the dyke no. 14 in table 1 and figure 4)

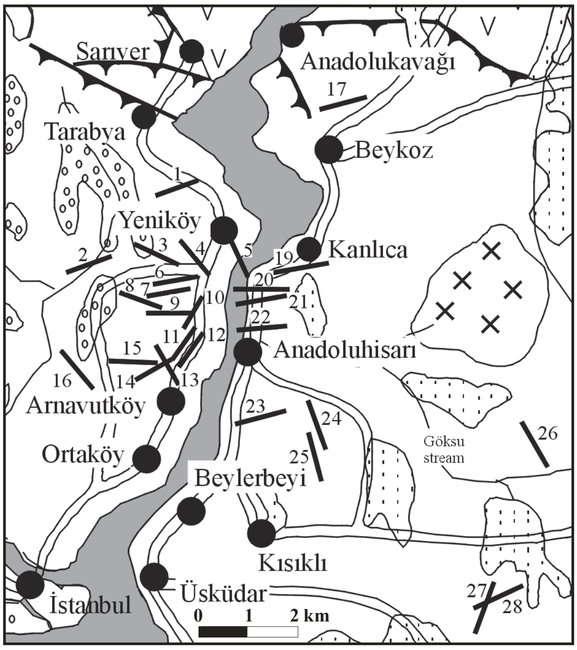

Figure 4- Dyke locations on both sides of the İstanbul strait (The dyke numbers are linked to those in table 1 and legend is same as figure 2)

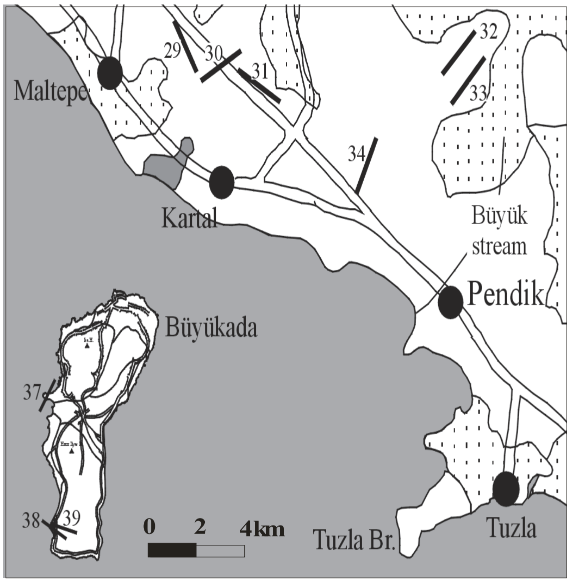

Figure 5- Dyke locations along the E-5 highway on the Küçükyalı-Pendik highway (The dyke numbers are linked to those in table 1 and legend is same as figure 2)

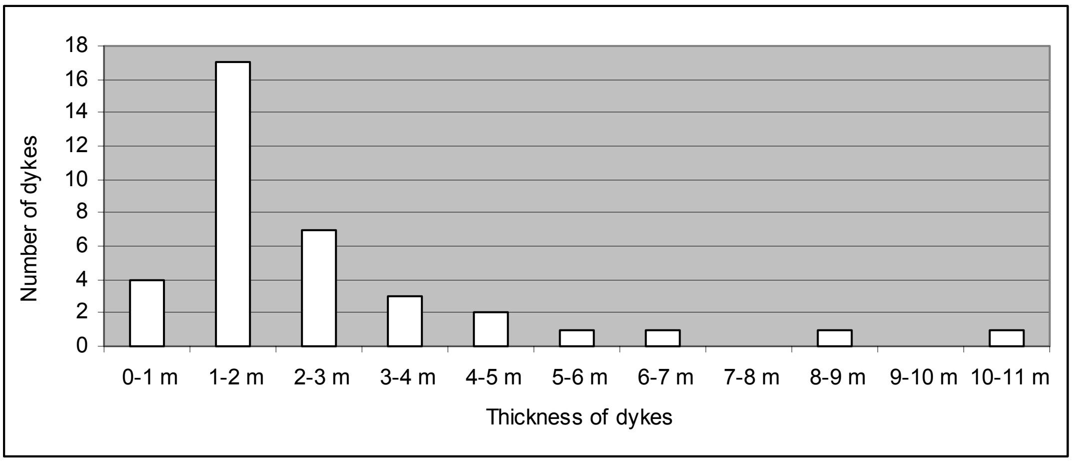

Figure 6- Thickness diagram for the 39 dykes in the İstanbul region.

Petrographic studies of samples show that the dykes are of andesitic or basaltic in composition and show a porphyritic texture. Plagioclase, hornblend and rarely augite form phenocrysts, 1.5 to 3.5 mm across, and are set on a fine-grained granular microlitic matrix. The dykes are commonly altered. Plagioclase is commonly replaced by sericite, and hornblende by chlorite.

DISCUSSION AND CONCLUSIONS

The strikes of the 39 well-described dykes are shown in the rose diagram in figure 7. The distribution of the strikes is highly scattered with a few prominent directions. There are two possibilities. The first one is that the Istanbul dykes constitute a local dyke swarm related to a yet unexposed pluton at depth. The second possibility is that the Istanbul dykes form a regional dyke swarm. These alternatives are discussed below.

- Local dyke swarm: The local dyke hypothesis is supported by the scatter in the distribution of the strikes of their dykes and their preferred concentration on both sides of the Bosphorus. In this view there is a pluton, similar to the Çavuşbaşı underneath the İstanbul strait, and the Istanbul dykes constitute the local dyke swarm of this pluton. In this model the Late Cretaceous stress distribution in the Istanbul region is controlled by the plutons.

- Regional dyke swarm: The preference of certain directions, shown by the strikes of the dykes, and their common presence in the northern parts of the Strandja Massif (Okay et al., 2001) support the regional dyke swarm model. The most prominent direction shown by the strikes of the dykes is N80°E (Figure 7). This direction is parallel to the expected rifting direction in the West Black Sea basin. A second preferential direction in the strike of the dykes is N40°E. These dykes are oriented parallel to the extension direction expected from the West Black Sea fault, thought to have been active during the Cretaceous (Okay et al., 1994). In this view the Istanbul dykes were emplaced in a complex stress regime created by the opening of the oceanic West Black Sea basin and by the movement of the West Black Sea Fault.

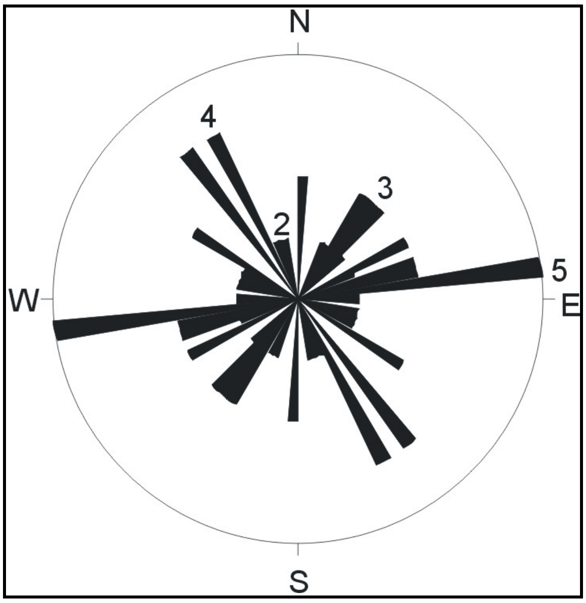

Figure 7- Strike diagram for the 39 dykes in the İstanbul region.

In this first study, devoted on the orientation of the Istanbul dykes, the number of dykes, whose strikes are measured confidently are limited. Therefore, it has not been possible conclusively to answer the question of whether the Istanbul dykes constitute a local or regional dyke swarm. However, the scatter in the direction of strikes of the dykes, and their spatial concentration on both sides of the İstanbul strait make the local dyke swarm model more probable. A conclusive answer to this problem can be found in future studies involving larger number of dykes.

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ABSTRACTS OF THE PAPER PUBLISHED ONLY IN THE TURKISH EDITION OF THIS BULLETIN

THE GEOLOGY AND PETROGRAPHY OF THE LATE NEOPROTEROZOIC - EARLY PALEOZOIC UNITS OF WESTERN TAURIDES (SW OF SANDIKLI, AFYON)

Semih GÜRSU* and M. Cemal GÖNCÜOĞLU**

Abstract.- The investigated area including the region of the junction of the Middle and Western Taurides, comprise distinctive Middle Taurides stratigraphy and tectonic features. The units, cropped out in Sandıklı, Karadirek, Başağaç, Akharım, Taşoluk and surrounding areas are divided into three parts as Sandıklı Basement Complex, Early Paleozoic Cover Units and Mesozoic Cover Units. Sandıklı Basement Complex is composed of Güvercinoluk formation and Kestel Çayı Porphyroid Suite from bottom to top; Early Paleozoic cover units consist of Göğebakan, Hüdai, Çaltepe and Seydişehir formations respectively; İlyaslı and Derealanı formations represent Mesozoic cover units. Mesozoic Cover Units is technically overlain by Sandıklı Basement Complex in the western part of the Sandıklı. Sandıklı Basement Complex is formed an overturned antiformal structure within NNW - SSW direction. Meta-sedimentary and meta-magmatic rocks of Sandıklı Basement Complex are described as Güvercinoluk formation and Kestel Çayı Porfiroid Suite. Kestel Çayı Porphyroid Suite is composed of meta-rhyolite/meta-dacite and meta-quartz porphyry dikes. Meta-quartz porphyry dikes of Kestel Çayı Porphyroid Suite intrude the meta-sedimentary rocks of SBC (Güvercinoluk formation) and meta-rhyolite/meta-dacite rocks which formed rhyolitic composition carapace. Sandıklı Basement Complex are cut by green-dark green colored continental tholeiitic basalt compositions dikes. Sandıklı Basement Complex rocks are unconformably overlain by Early Cambrian Göğebakan formation. Upward, the formation is transitional to Celiloğlu member of Hüdai formation. The unit's age indicate Tommotian (Early Cambrian) age according to trace fossils at the transition between Celiloglu member of Hüdai formation and Göğebakan formation. Celiloğlu member is made up of alternation of green colored meta-mudstone/meta-siltstone and green-beige colored meta-sandstone and is transitional to Örenkaya quartzite member with slate bearing meta-sandstone (quartzite). Hüdai formation is conformably overlain by Lower-Middle Cambrian Çaltepe formation, which is made up of reddish-brown colored recrystalized dolomite and pink colored nodular limestones. The unit continues Middle Cambrian - Early Ordovician Seydişehir formation including anchi-metamorphic milstone, nodular limestones, shales and sandstones, which have a narrow contact in the investigated area. Mesozoic cover units are represented by Early Liassic İlyaslı formation with Early Liassic-Early Malm Derealanı formation. It is considered that the unconformity of Sandıklı Basement Complex and Early Cambrian cover units correspond to Main Pan-African unconformity in Menderes Massif (Şengör et. al., 1984) and Menderes Massif, Eastern Taurides and similar units are pertaining to parts of Pan-African basement.

Key words: Cadomian basement, Early Palaezoic cover, geology, petrography, Sandıklı

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LITHOFACIES PROPERTIES OF ANTALYA TUFAS

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Abstract.- The tufa term is described as secondary calcium carbonate deposits which are deposited by biologic and/ or physicochemical processes under cool water conditions and contain macro and micro scales plant, animal remains and bacteria (especially cyanobacteria). Tufas have especially deposited at Quaternary and recent time. The study area, located in Antalya city borders, constituted by primary three main terraces, Döşemealtı Plateau (Upper Terraces), Düden Plateau (Lower Terraces) and the third terraces under the sea level. These terraces contain nine second and the third order small terraces which determined by using GIS. As a result of this study, ten lithofacies which have deposited in fluvial, paludal, lacustrine and cascade-barrage environments are described. These are; 1. phytoherm framestone facies, 2. phytoherm boundstone fades, 3. micritic tufa fades, 4. phytoclastic tufa facies, 5. oncoidal tufa facies, 6. intraclastic tufa facies, 7. microdetrital tufa facies, 8. palaeosols, 9. pisolitic tufa facies (channel and pool types) and 10. intraformational tufa facies. These different types have formed in low regime surface flows/ streams, marshes, lake- pool and cascade- barrage environments that developed from springs and have different hydrologic conditions.

Key words: Afyon, Karamık Lake, saccarites, invert sugar, Emmerich-A method.

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DETERMINATION OF TOTAL SUGAR CONTENT IN SEDIMENTS WITH EMMERICH-A METHOD AND ITS IMPORTANCE: AN EXAMPLE FROM AFYON-KARAMIK LAKE

Gültekin Kavuşan** and Ahmet Orhan***

Abstract.- Karamık lake is located at the southeast of Şuhut county in the vicinity of Afyon region and has been developed in the control of neotectonic faults. Around the lake area 6 shallow boreholes were drilled from which 5 organic material rich ones have been evaluated in this study. Samples have been collected with a special pvc casing mounted on portable-hand drilling apparatus. According to the analysis performed at organic material rich parts of samples, approximately 58,35% surface moisture, 12,89% hygroscopic moisture, 30,96% organic material content and 69,04% ash content have been determined. By using Emmerich-A analysis method for inverted sugar content of Karamık lake actual sediments have been determined as 6,67 ppm at air-dried base and 13,66 ppm at dry-mineral matter free base. The average pH value of same samples is 8,05. The relationships between pH/invert sugar and OM/invert sugar of the Karamık sediments are directly proportional, whereas total moisture content/invert sugar ratio changes are indirectly proportional. Although sugars could have high dissolving ratio in water, in the lack of water content it has been observed that all of the hygroscopic moisture content was consumed during the invertisation. In terms of basin geometry, sugar content increase in the sediments of organic material rich sapropelite which deposited in transition from lake water to the swampy areas. Also sugar content increases in the NW part of the Karamık lake region, characterized as regularly and uniformly sediment transportation, whereas the sugar content decreases around the Koçbeyli-Aydoğmuş fault region where the aluvial fan deposits rich in coarse grained sediments occur and leaned the NE part of the lake.

Key words: Afyon, Karamık Lake, saccarites, invert sugar, Emmerich-A method.