PALEOMAGNETIC EVIDENCE OF THE ROTATIN OF IZNIK-MEKECE AREA

İZNİK - MEKECE ALANI DÖNMESİNİN PALEOMAĞNETİK DELİLİ

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ABSTRACT: This paleomagnetic study is carried out in order to determine the rotation of the Iznik-Mekece area which is situated on the Intra-Pontide suture zone and Mekece Fault. For this purpose, the Eocene aged volcanic rocks were sampled on the both sides of the fault. In the result, the mean remenent magnetization directions of the northern and southern blocks are shown 25° clockwise and 35° counter-clockwise rotations with respect to the axial dipol position, respectively. The obtained clockwise and counter-clockwise rotations could be resulted from blocks rotations which are situated in the two strands of the North Anatolian Fault Zone and southern part of the Iznik-Mekece Fault, respectively.

Key words: Paleomagnetism, remanent magnetization, block rotations.

ÖZ: Bu Paleomağnetik çalışma Intra-Pontit sütür zonu üzerindee bulunan İznik-Mekece sahasının dönmesini saptamaya yöneliktir. Bu amaçla, fayın her iki bloku üzerinden Eosen yaşlı volkanik kayaç örnekleri toplanmıştır. Sonuçta, ortalama mıknatıslanma doğrultularının eksensel dipol posizyonuna göre kuzey ve güney blokun sırasıyla saat ve saatin tersi yönünde 25° ve 35° döndüğü saptanmıştır. Elde edilen bu dönmelerin Kuzey Anadolu Fay Zonunun iki kolu arasında kalan blok ile İznik-Mekece Fayının güneyinde kalan bloğun dönmelerinden kaynaklandığı ifade edilebilir.

Anahtar Kelimeler: Paleomagnetizma, kalıntı mıknatıslama, blok dönmeleri.

INTRODUCTION

In recent years, paleomagnetic studies were contributed to understand the tectonic evolution of the complex structures (Van der Voo and Channel, 1980; Kleist et al., 1984).

Paleomagnetic studies carried out especially in Pontide and Anatolite-Toride platforms were contributed to the developments of paleotectonic models (Van der Voo, 1968; Orbay, 1979; Orbay and Bayburdi, 1979; Baydemir, 1982; Güner, 1982; Evans et al., 1982; Sarıbudak, 1989; Sarıbudak et al., 1990; Evans and Hall, 1990).

Paleotectonic evolution of the Sakarya Contient is given in the model of Şengör and Yılmaz (1981) further elaborated in Şengör et al. (1984) (Figure 1). In this model, the Sakarya Continent remained as a deeply submerged platform till its collision with the southern margin of Laurasia in the Early Tertiary. This collision zone is called Intra-Pontide suture. After Late Paleocene-Early Eocene docking event, the Anatolite-Toride platform collided with the southern margin of Sakarya contient. This event generated the Izmir-Ankara suture zone by closure of the Vardar Ocean in this region.

Iznik-Mekece region is situated within the Intra-Pontide suture zone and Mekece fault which is on extention of the North Anatolian Fault Zone passes through the area as shown in Figure 2. It is easy to see from the geological map that Iznik-Mekece Fault pass throughout the pyroksene-ogite andesitic rocks and its estimated total slip is approximately 30-35 km (Akartuna, 1968; Bargu, 1982).

The aim of this study is to try to determine the possible rotation of the region using the directions of the remanent magnetizations obtained from Eocene aged volcanic rocks.

PALEOMAGNETIC ANALYSIS AND RESULTS

The sampling sites are shown on the geological map in the Figure 2. The eleven hand samples including IK(1-5) from the basalts and IM(1-5), IC6 from the andesites which are suggested as a ogite andesite by Akartuna (1968) and Pyroksen andesite by Bargu (1982) and also eleven hand samples including ID(1-6) and IC(1-5) from ogite andesites were collected from the northern and southern blocks of the fault, respectively.

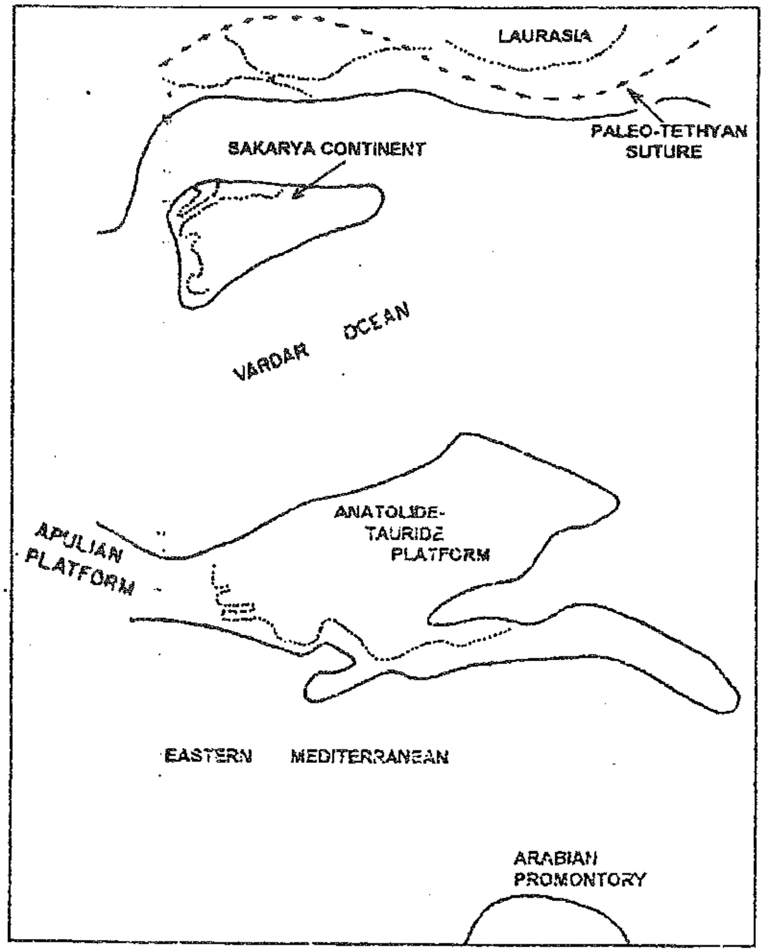

Figure 1. Paleotectonic skech map of the Sakarya continent given by Şengör and Yılmaz (1981).

Şekil 1. Şengör ve Yılmaz (1981) tarafından verilen paleotektonik harita.

The natural remenent magnetization directions of the samples are plotted on Wulf projection as seen in Figure 3. When we looked at the figure, it is seen that the most of the directions are exhibit large disribution and some of them have reverse magnetization. The secondery magnetization of the samples are removed by using the alternating magnetic field. One pilot specimen from each hand sample was subjected to alternating magnetic field cleaning in eight progressive steps, in order to reduce the effect of secondery magnetization. The optimum field for each hand sample was decided by using the principle of minimum direction change in remanence vector, in which the natural and treated remanent magnetization directions of each pilot specimen were plotted on a Wulf stereogram for successive steps of demagnetizing field. Best-fit method on Zijderveld plots is also used to obtained cleaned remanence directions. The results obtained from two pilot specimens (IM314 and IC112) are shown in Figure 4. It clearly exhibits that the pilot samples lost their secondery magnetizations at the end of third step (175 Oe). The shape of "intensity-alternating field" curves of the specimens are given in the same figure indicate that the magnetic minerals responsible of their remanent magnetizations have different physical and or chemical properties. Three hand samples (IC6, ID6 and IK4) were rejected after alternating field treatment because they exhibited unstable magnetizations.

The mean remanent magnetization directions of each sites and their average values are given in Table 1 and shown in Figure 5. The mean remanent magnetization directions of IM5 and ID2 have different directions from the others, therefore, these hand samples were extracted from the group means. As it is seen from Table 1 and Figure 5 the denclinations are different (D=33° for northern and D=320° for southern blocks) but their inclinations are similar to each other (I=59° for northern and I=59° for southrn blocks).

The radius of the coefficients ($^{\alpha}95$) of average values of the mean remanent magnetization direction of two groups are 7° and 9°, respectively.

In the calculation of the mean directions and related statistical parameters, equal weight was given to each specimen in calculating the hand sample mean. Similarly, the flow mean direction were calculated giving equal weight to each hand sample. The results are given in Table 1 and plotted in Figure 5. The remanent magne-

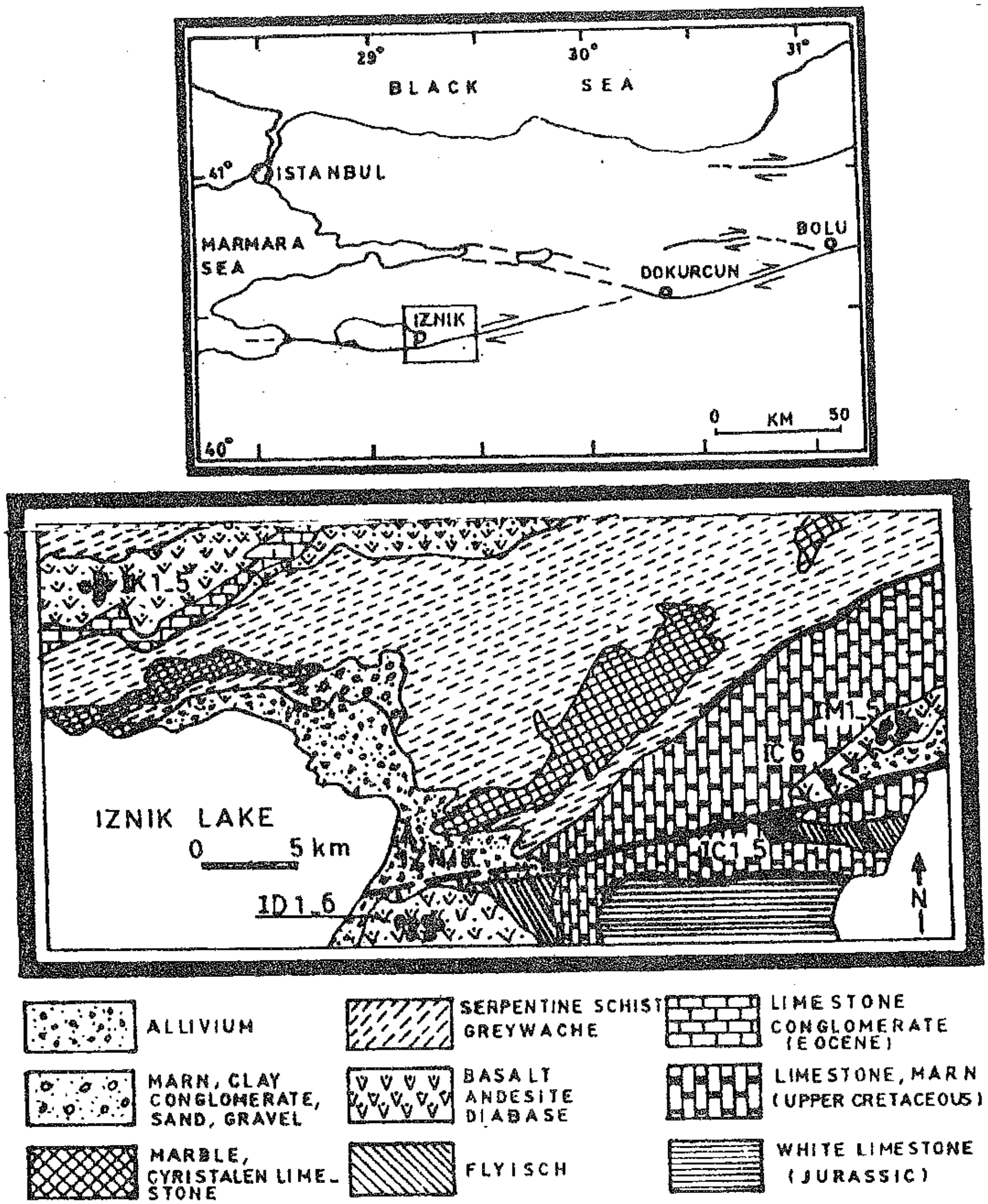

Figure 2. The studying area and its geological map. The sampling sites are shown by small full circles.

Şekil 2. Çalışma bölgesi ve onun jeolojik haritası. Örnek yerleri içi dolu dairelerle gösterilmiştir.

tization directions of IM5 and ID2 were not included to the site mean calculations, since their mean magnetization directions were distincly different then the directions obtained from other hand samples collected from the same sites.

The sites IK and IM are located on the Northern and the sites ID and IC are located on the southern blocks of the Iznik-Mekece Fault, Figure 6. The site means for Northern and Southern blocks are D=33°.4; I=59°.2 and D=320°; I=59°.5, respectively.

The inclination angle expected from axial dipole field at 40° north and south latitude is almost equal to the inclination angles obtained from mean of site means (I=59°). This means that the formations sampled have not experienced any N-S movements since Eocene. The declination angles (D) obtained for northern and sout-

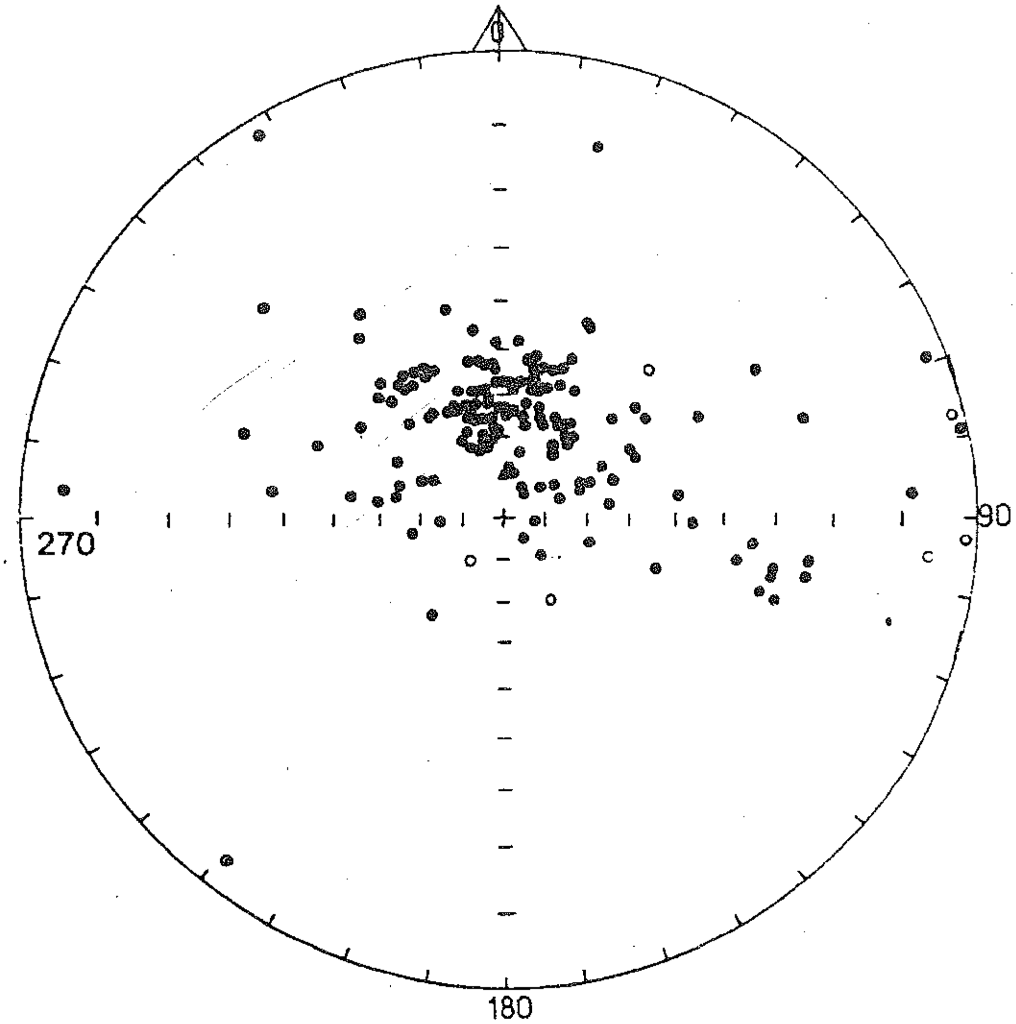

Figure 3. Distribution of the NRM directions of the all samples. Full and open circles represent the normal and reverse magnetizations, respectively.

Şekil 3. Tüm bölgelerin DKM doğrultularının dağılımı. İçi dolu ve boş daireler normal ve ters mıknatıslanmaları göstermektedir.

hern blocks, on the other hand, are distincly different from each other and also from the declination angle expected from axial dipole (D=0). Therefore, one can declare that the northern and southern blocks of the Iznik-Mekece Fault are rotated approximately 33° in clockwise and 40° in counter-clockwise, respectively

DISCUSSION

In the last decade and a half, numerous paleomagnetic studies have led to the recognation of significant fault bounded block rotations within strike-slip fault zones or broad shear zones (McKenzie and Jacson, 1983; Beck, 1988 and Lamb, 1988).

The rapid rotation of blocks occurs in the deforming zones of a strike-slip environment, block bounded by left lateral faults rotate counter-clockwise those bounded by right-lateral faults rotate clockwise (Gallo et al., 1980; Gorfunkel, 1988). İznik-Mekece area bounded by two strands of the right-lateral North Anatolian Fault as shown in Figure 6. The obtained mean remanent magnetization directions from IK and IM sites exhibit 33° clockwise rotation which is in agreement with the result given by McKenzie and Jackson (1983), Beck (1988) and Lamb (1988). The obtained mean remanent magnetization directions from IC and ID sites which are situated on the southern block exhibit 40° counter-clockwise rotation. The southern block is bounded between normal fault which passes along south of Yenişchir and Iznik-Mekece right-lateral fault. 40° counter-clockwise rotation of the southern block can be explained as follow: The northward displacement of the southern block caused by Yenişehir normal fault could be compansated by the strike slip movement of the Iznik-Mekece Fault, resulting the above mentioned rotation.

In the shear zones the total displacement of a strike-slip fault is given by equation of D=2a ϕ (McKenzie and

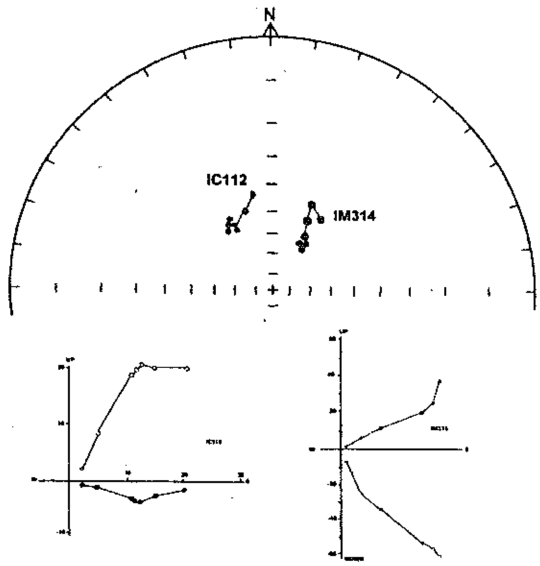

Figure 4. Wulf and orthogonal projections of the IC112 and IM314 pilot samples.

Şekil 4. IC112 ve IM314 pilot örneklerinin wulf ve ortogonal projeksiyonları.

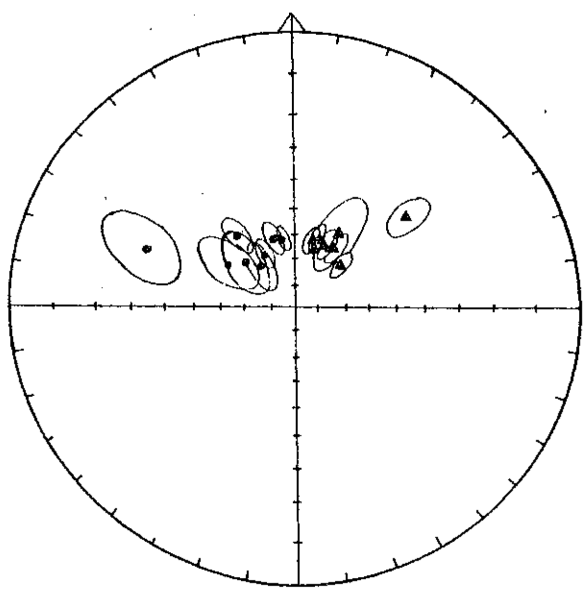

Figure 5. The mean remanent magnetization directions of each sites and their α_{95} circles. Full circle and triangle directions are belong southern and northern blocks of the fault, respectively.

Şekil 5. Herbir ölçü noktasına ait ortalama kalıntı mıknatıslanma doğrultuları ve bunlara ait α_{95} çemberleri. İçi dolu daireler ve üçgen ile gösterilen doğrultular fayın güney ve kuzeyine aittir.

Jackson, 1983), in which a and D represent the width and total displacement of the shear zone, respectively and ϕ stans for rotation angle.

The distance between the northern and southern boundery of the strands of the block a=25 km, and ϕ=0.576 radian (D=33°), Then we get a total displacement D=29 km for Iznik-Mekece strike-slip fault. The total displacement of the North Anatolian Fault Zone is given about 100 km by Şengör (1979); and this displacement is decrease westward Şengörr, Burke and Dewey, 1982). The actual displacementof the İznik-Mekece fault observed in the field by Akartuna (1968) and Bargu (1982) is 35 km, which is in a good agreement with the results obtained from the above mentioned equation. A bigger rotation (212° clockwise) was obtained by Sarıbudak et al. (1990) for the named "Almacık Flake"

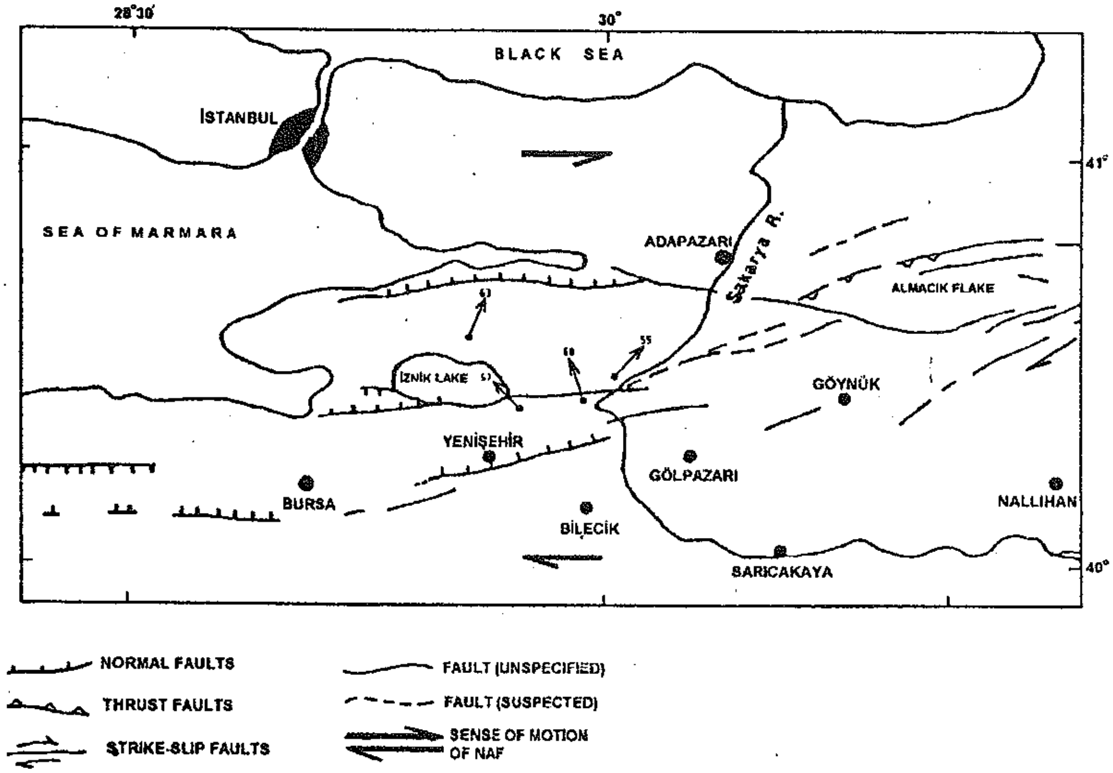

Figure 6. Tectonic lines of the studied area and obtained mean paleomagnetic directions.

Şekil 6. Çalışma sahasındaki tectonik hatlar ve elde edilen ortalama mıknatıslanma doğrultuları.

Table 1. Mean remanent magnetization directions of the sites.
Tablo 1. Örnek yerlerine ait ortalama kalıntı mıknatıslanma doğrultuları.

North Block		In-situ			South Block		In-situ		
Site	Rock Type	Dec.	Inc.	α95	Site	RockType	Dec.	Inc.	α95
IK1		17.6	64.1	2.5	IC1	OJITE-	323.5	51.9	8.3
IK2	BASALT	19.3	62.8	2.5	IC2	PYROXENE	330.8	65.8	4.5
IK3		35.3	61.1	7.4	IC4	ANDESITE	344.4	60.6	7.6
IK5		23.1	61.2	6.4	IC5		347.7	60.0	2.4
IM1	OJITE-	31.8	55.3	15.3	ID1	OJITE-	303.5	58.3	14.3
IM3	PYROXENE	27.3	62.9	3.1	ID2	PYROXENE	291.9	32.8	17.9
IM4	ANDESITE	49.7	65.7	3.7	ID3	ANDESITE	316.5	63.5	13.3
IM5		52.1	35.4	7.2	ID5		320.9	69.8	10.3
MEAN		33.4	59.2	7.3			320.0	59.5	9.5

which is situated just east of the studied area. Therfore, the result obtained from this study for Iznik-Mekece area (~60°) seems to be reasonable.

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ÖZET

Kuzey Anadolu Fay Zonunun batı ucunda yer alan İznik-Mekece yöresinden ve fayın her iki bloğu üzerinde beş mevkiden Eosen yaşlı volkanik kayaçlardan toplam 22 el örneği alınarak bu mevkilerin ortalama kalıntı mıknatıslanma doğrultuları elde edilmiş ve bölgenin dönme miktarı saptanmıştır. İkincil kalıntı mıknatıslanmalar, örneklere uygulanan alternatif mağnetik alanla kaldırılmıştır. Her bir mevkinin ortalama kalıntı mıknatıslanma doğrultuları (Tablo 1) gözönüne alındığında sapma açıları arasında görülen 60° nin bölgenin dönmesini yansıttığı söylenebilir.

Shear zonlarında doğrultu atımlı bir fayın toplam atımı D=2aϕ bağıntısı ile verilmektedir. a ve D sırasıyla shear zonunun genişliğini ve toplam atımını, ϕ de bloğun dönme açısını göstermektedir. Çalışma bölgesinde a=25 km ve ϕ=0.576 radyan (D=33°) alındığında toplam atım 29 km olarak saptanmaktadır. İznik-Mekece fayının gözlenen atımının 35 km olduğu gözönüne alındığında yukarıdaki denklemden elde edilen sonucun iyi bir uyum gösterdiği anlaşılabilir.

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