Trace element and Sr-Nd isotope geochemistry of the alkali basalts observed along the Yumurtalık Fault (Adana) in southern Turkey

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ABSTRACT

Young volcanics erupted since late Pliocene as a result of lithospheric extension within the transtensional zones along the NE-SW trending left-lateral Yumurtalık fault zone that mark the boundary between the African and the Anatolian plates in southern Turkey. These volcanics are characterized by alkali olivine basalts. The REE patterns exhibit a strong fractionation characterized by (La/Yb)_N ratio between 22 and 6. Primitive mantle normalized incompatible trace element patterns exhibit close similarity to OIB. Ratios of some selected incompatible trace elements (i.e., Ce/Y=1.4-3.8, Zr/Nb=3.9-6.5, La/Ba=0.05-0.1, La/Nb=0.6-0.8, Zr/Ba=4.0-4.8) are also well comparable to those of ocean island basalts. The ^{87}Sr/^{86}Sr ratios show low values (between 0.703081 to 0.703920), whereas the ^{143}Nd/^{144}Nd ratios show high values (ranging from 0.512601 to 0.512986), suggesting an OIB signature. All the evidence suggest that the intracontinental volcanics in this region were derived from an asthenospheric mantle following the fractures of the continental lithosphere that resulted from the left lateral strike-slip fault system bounding the African-Anatolian plates since Late Pliocene in southern Turkey.

Key Words: Adana, alkali basalt, Sr-Nd isotopes, Turkey, Yumurtalık fault

ÖZ

Güney Türkiye’de, genç volkaniklar Geç Pliyosen’den beri litosferin genelmesi sonucu Afrika-Anadolu plakalarını sınırlayan KD-GB güdi sol yönlü Yumurtalık doğru atımı fayın boynuca gelisen açılma zonlarında yüzeye ulaşmışlardır. Bu volkanik kayaçlar alkali olivinli bazaltlar ile temsili ediliyor. Bu volkaniklerin nadir toprak element içerikleri yüksek derecede aynlaşması [(La/Yb)_N]=22-6 göstermektedir. İlk sel manto generalize edilen uyumuz iz element içerikleri okyanus adası bazaltlara yakın benzerlik göstermektedirler. Bazı uyumuz ise element oraneları da (Ce/Y=1.4-3.8, Zr/Nb=3.9-6.5, La/Ba=0.05-0.1, La/Nb=0.6-0.8, Zr/Ba=4.0-4.8) okyanus adası bazaltlara uyumluluk göstermektedir. ^{87}Sr/^{86}Sr oraneları düşük (0.703080-0.703918 arasında) olup, buna karşın ^{143}Nd/^{144}Nd oraneları yüksek (0.512600-0.512985) ve okyanüs adası bazalt özelliğini sahiptir. Bu volkanik kayaçlardan elde edilen jeokimyasal veriler, güney Türkiye’de gözlenen kıkırdak volkaniklerin Geç Pliyosen’den beri Anadolu-Afrika plakaları arasındaki sının teşkil eden sol yönlü doğrultu atımı fayların neden olduğu kitalar kabukta kabukta kırık olarak buna astenosferik mantodan tıkanıklıkların işaret etmektedir.

Anahtar Kelimeler: Adana, alkali bazalt, Sr-Nd izotopları, Türkiye, Yumurtalık fayı
INTRODUCTION

Alkali basalts all over the world namely the Columbia River (Nelson, 1980; Carlson et al., 1981; Carlson, 1984), the Deccan (Mahoney et al., 1985; Mahoney, 1988), the Parana (Hawkesworth et al., 1986), and the Siberian Flood basalts (Sharma et al., 1991), the Massif Central (Chauvel and Jahn, 1984), and the Karoo basalts (Hawkesworth et al., 1984), the alkali-olivine basalts along the African-Anatolian plate boundary (Parlak et al., 1997) and Karasu valley-northern part of Dead Sea rift- basalts (Çapan et al., 1987; Parlak et al., 1998) from southern Turkey, and the volcanics of Aegean region (Seyitoğlu and Scott, 1992; Yılmaz, 1990) have been studied in terms of their major-trace element and Nd-, Sr-, Pb- and O-isotopic compositions since more than a decade. Petrogenetic problems of alkali basalts have been widely discussed in recent years, both from geochemical/isotopic and experimental/petrologic points of view (Chauvel and Jahn, 1984). Models for alkaline rock genesis are extremely various, i.e. some of them involve very small degrees of partial melting (Gast, 1968; Kay and Gast, 1973), whereas the others large degrees of melting (Sun and Hanson, 1975). For the source characteristics of alkaline basalts; some people favored chondritic mantle source (Sun and Hanson, 1975; Frey et al., 1978; Sharma et al., 1991) whereas others favoring a mantle metasomatism in order to account for the enrichment in highly incompatible (LREE-enrichment) elements (Carter et al., 1978; Menzies and Murthy, 1980; Wass and Rogers, 1980; Chauvel and Jahn, 1984). Such detailed studies were carried out in distinct part of Turkey. Yılmaz (1990) compared the young volcanic rocks both in western and eastern Anatolia and stated that the calcalkaline rocks dominated by andesitic group occurred during the Late Oligocene-Early Miocene in compressional regime and the alkaline rocks dominated by basalts occurred during the extensional regime (Middle Miocene and younger). Seyitoğlu and Scott (1992) studied the Late Cenezoic volcanic rocks within the grabens of the Aegean region. They pointed out that the young volcanic rocks (Late Miocene and younger) exhibit alkaline character due to continued extension after the Late Oligocene-Early Miocene and contribution of the asthenospheric material. Parlak et al (1997) have presented the major-trace element as well as the mineral chemistry of the basaltic rocks along the African-Anatolian plate boundary and pointed out that the volcanic rocks in this region are mainly dominated by alkali-olivine basalts and erupted within the transtensional zones along the African-Anatolian plate boundary since Late Pliocene.

In this paper, Sr-Nd isotopic and trace (including REE) element data on the alkali-olivine basalts erupted along the Yumurtalık fault are presented in order to characterize the isotopic composition of these rocks and hence their mantle source.

REGIONAL GEOLOGY

The Maraş triple junction has a complex structural interrelation where Anatolian, African and Arabian plates collided since late Cretaceous (Sengor and Yılmaz, 1981; Karig and Kozlu, 1990; Kozlu, 1987; Robertson and Dixon, 1984). The boundary between African and Anatolian plates is marked by Cyprus-Misis-Andırırn trend along which transtentional regime has been dominant since late Pliocene. As a result of this extension, intracontinental basaltic volcanics were erupted along the lineament of the left lateral Yumurtalık fault in southern Turkey (Figure 1) (Kozlu, 1987; Kelling et al., 1987; Karig and Kozlu, 1990; Parlak et al., 1997). These volcanic rocks rest on the Late Pliocene-Quaternary continental sediments and are intercalated with the Quaternary terrace-conglomerates in the Misis-Andırırn basin (Kozlu, 1987).The Plio-Quaternary alkali-olivine basalts are often intercalated with agglomerates and tuffs. They show microlitic-porphyric, ophitic and sub-ophitic textures. The alkali basalts are represented by euhedral olivine (Fo84-79) phenocrysts with variable grain size of 0.3-5.5 mm, laths of plagioclase (An46-58) with a grain size of 0.5-3 mm and anhedral clinopyroxenes (Ca46-48, Mg39-41, Fe11-13) with the grain size of 0.4-0.8 mm. The groundmass is commonly composed of microliths of plagioclase (An44-63) and clinopyroxene (Ca55-51, Mg38-43, Fe5-7).
ANALYTICAL METHOD

Fourteen samples of the alkali-olivine basalts were employed for REE, Sr and Nd isotopic compositions. Sr and Rb concentrations were determined by XRF spectrometer on glass beads fused from ignited powders to which Li$_2$B$_4$O$_7$ was added (1:5), in a gold-platinum crucible at 1150°C. REE, Sm and Nd concentrations were measured by ICP-AES with an analytical error ±5-10% in the Mineralogy Department at Geneva University (Voldet, 1993). Sr and Nd were isolated from the same sample dissolution by using HF+HNO$_3$ method of Hart and Brooks (1974). 500 mg powder of each sample was loaded into a 15 ml teflon bomb capsule. 4 ml of concentrated HF and 0.5 ml of concentrated HNO$_3$ were added, and the bomb was sealed in an aluminum jacket at 200°C for 5 hours. Then the HF and HNO$_3$ were evaporated to dryness. Dissolution was further assured and HF was eliminated by evaporating twice with 1 ml 6M HCl at 130°C. The samples were then dissolved in 1 ml of 2.5M HCl, centrifuged, and the solution was loaded on column for separation of Sr and Nd. Sr and Nd isotopic ratios were determined at the University of Geneva on a 7-collectors Finnigan MAT 262 thermal ionization mass spectrometer with extended geometry and stigmatic focusing. The data are recalculated with reference to the following standards, namely Eimer and Amend $^{87}$Sr/$^{86}$Sr=0.7080 and La Jolla standard $^{143}$Nd/$^{144}$Nd=0.50403. Sr and Nd isotopic ratios were corrected for mass fractionation assuming $^{86}$Sr/$^{88}$Sr=0.1194 and $^{146}$Nd/$^{144}$Nd=0.721903, respectively. The mean value of the standards are for Eimer and Amend $^{87}$Sr/$^{86}$Sr=0.70801±06 (2σ) and for La Jolla $^{143}$Nd/$^{144}$Nd= 0.511797±04 (2σ) during the period of data acquisition.
**GEOCHEMISTRY**

**Major and trace element**

Major and trace element (including REE) concentrations of the basaltic rocks are shown in Table 1. As is realized from the results of major element analysis, the reported values of the Loss On Ignition (LOI) are minus (-). This may be explained as follows; during the LOI process some samples take on some oxygen in the furnace due to oxidation of some Fe$^{+2}$ to Fe$^{+3}$. Consequently, the reported value for LOI becomes lower than the actual volatile content (Ragland, 1989). Variations of the major oxides are plotted against SiO$_2$ as differentiation index in Figure 2. It is apparent that two different suites are present in the study area. First group is represented by low SiO$_2$ (43.78-46.74 %), Al$_2$O$_3$ (14.41-16.23 %) and high TiO$_2$ (2.5-2.84 %), MgO (7.31-9.45 %), CaO (7.8-10.29 %), FeO (11.34-13.23 %), P$_2$O$_5$ (0.71-1.0 %), MnO (0.17-0.18 %), and K$_2$O (1.41-2.56 %). Whereas the second group is characterized by high SiO$_2$ (48.27-48.67 %), Al$_2$O$_3$ (15.99-16.23 %) and low TiO$_2$ (2.36-2.48 %), MgO (5.95-6.01 %), CaO (9.69-9.72 %), FeO (12.38-12.65 %), P$_2$O$_5$ (0.39-0.43 %), MnO (0.16-0.17 %), K$_2$O (0.87-0.94 %). Despite the difference in terms of major element contents, all the basaltic rocks are characterized by alkali basalts in the Nb/Y versus Zr/TiO$_2$ diagram of Winchester and Floyd (1977) (Figure 3). The alkaline affinity of these basaltic suites has also been proved in terms of plagioclase and clinopyroxene mineral chemistry (Parlak et al., 1997).

Incompatible elements are those most likely to be transposed by melts and other fluids passing through the mantle. Therefore, these elements are most likely to preserve evidence of mantle enrichment and depletion processes in their relative abundances (Fitton et al., 1991). Primitive mantle normalized incompatible trace element variations of the alkali basalts are shown in Figure 4 together with OIB and MORB. It is clearly seen that the studied samples have similar trace element patterns compared to OIB in general. The samples with high SiO$_2$ have lower LILE (Rb, Sr) and HFSE (Nb, La, Ce, Pr, Nd, Sm, Zr, Eu) than the samples with low SiO$_2$.

Chondrite-normalized REE patterns of the alkali basalts are shown in Figure 5. All the samples are represented by LREE enrichment and the distinction between two groups can be summarized as (i) high LREE content of the samples with low SiO$_2$ (La: 30.8-40.9 ppm) compared to the samples with high SiO$_2$ (La: 16.1-18.5 ppm) and (ii) more fractionated REE patterns of the former (La/Yb$_n$= 14.2-21.6 and Gd/Yb$_n$= 2.4-4.1) compared to the latter (La/Yb$_n$ = 6.4-9.5 and Gd/Yb$_n$ = 2-2.9), respectively. Cullers and Graf (1984) stated that LREE enrichment, no Eu anomaly and the ratios of Eu/Sm=0.31-0.35 are characteristic features of ocean island and continental alkali basalts.

The distinction of these alkaline basalts with regard to Primitive mantle-normalized incompatible trace element variations and chondrite-normalized REE patterns suggest that these basaltic rocks are derived: (i) from mantle sources of different compositions (White et al., 1979; Humpris and Thompson, 1983), (ii) from a single parental magma by fractional crystallization (Yoder and Tilley, 1962; O’Harra, 1968; Presnall et al., 1978), (iii) from the same source under different conditions (i.e., at different depts and different degrees of partial melting) (White et al., 1979). These points will be reconsidered in discussion section of the paper.
Table 1: Major-trace element (REE) analyses of the alkaline rocks in southern Turkey.

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<tbody>
<tr>
<td>SiO₂</td>
<td>43.82</td>
<td>43.83</td>
<td>44.14</td>
<td>43.78</td>
<td>43.96</td>
<td>46.74</td>
<td>48.49</td>
<td>48.35</td>
<td>48.27</td>
<td>48.67</td>
<td>44.25</td>
<td>44.04</td>
<td>44.26</td>
<td>44.25</td>
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<tr>
<td>TiO₂</td>
<td>2.84</td>
<td>2.80</td>
<td>2.70</td>
<td>2.83</td>
<td>2.84</td>
<td>2.50</td>
<td>2.45</td>
<td>2.36</td>
<td>2.46</td>
<td>2.48</td>
<td>2.82</td>
<td>2.81</td>
<td>2.78</td>
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<tr>
<td>MnO</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.17</td>
<td>0.16</td>
<td>0.16</td>
<td>0.16</td>
<td>0.18</td>
<td>0.18</td>
<td>0.18</td>
<td>0.17</td>
<td></td>
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<tr>
<td>Na₂O</td>
<td>4.26</td>
<td>4.56</td>
<td>4.24</td>
<td>4.35</td>
<td>4.32</td>
<td>5.19</td>
<td>3.56</td>
<td>3.38</td>
<td>3.53</td>
<td>3.46</td>
<td>3.58</td>
<td>3.66</td>
<td>3.78</td>
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</tr>
<tr>
<td>K₂O</td>
<td>1.72</td>
<td>1.68</td>
<td>1.68</td>
<td>1.56</td>
<td>1.61</td>
<td>2.56</td>
<td>0.91</td>
<td>0.87</td>
<td>0.94</td>
<td>0.92</td>
<td>1.41</td>
<td>1.43</td>
<td>1.45</td>
<td>1.49</td>
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<tr>
<td>P₂O₅</td>
<td>1.00</td>
<td>0.99</td>
<td>0.95</td>
<td>1.00</td>
<td>0.98</td>
<td>0.71</td>
<td>0.43</td>
<td>0.39</td>
<td>0.42</td>
<td>0.43</td>
<td>0.88</td>
<td>0.90</td>
<td>0.86</td>
<td>0.91</td>
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<tr>
<td>LOI</td>
<td>-0.45</td>
<td>-0.39</td>
<td>-0.42</td>
<td>-0.48</td>
<td>-0.58</td>
<td>-0.35</td>
<td>-0.33</td>
<td>-0.32</td>
<td>-0.36</td>
<td>-0.50</td>
<td>-0.46</td>
<td>-0.57</td>
<td>-0.58</td>
<td>-0.68</td>
</tr>
<tr>
<td>Total</td>
<td>99.83</td>
<td>99.91</td>
<td>99.81</td>
<td>99.61</td>
<td>99.88</td>
<td>100.20</td>
<td>100.00</td>
<td>99.44</td>
<td>99.71</td>
<td>99.97</td>
<td>99.64</td>
<td>99.10</td>
<td>100.03</td>
<td>99.86</td>
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</table>

Sr-Nd Isotope

The Sr- and Nd-isotopic ratios of the alkali-lavine basalts are given in Table 2. The isotopic ratio of the \(^{87}\text{Sr}/^{86}\text{Sr}\) is low (ranging from 0.703081 to 0.703920) whereas the \(^{143}\text{Nd}/^{144}\text{Nd}\) ratio is high (ranging from 0.512601 to 0.512986) and the \(^{143}\text{Nd}\) is between -0.7 and +6.8 (see Table 2). Figure 6a shows a plot of the \(^{87}\text{Sr}/^{86}\text{Sr}\) and \(^{143}\text{Nd}\) for the alkali-lavine basalts. In this diagram all the samples, except one (OP-5 = -0.7), plot almost within the present-day OIB field defined by Hart and Staudigel (1989) and are comparable with the Siberian Flood Basalt Province (DePaolo and Wasserburg, 1979; Sharma et al., 1991).
Figure 2: Plots of the major oxides versus SiO₂, showing the difference for two groups of rocks (⊕ is low silica and ⊖ is high silica samples).

Table 2: Sr-Nd isotope data for the alkali basalts in southern Turkey

<table>
<thead>
<tr>
<th>Sample No</th>
<th>Rb</th>
<th>Sr</th>
<th>^87/86Rb</th>
<th>^87Sr/86Sr</th>
<th>^87Sr/86Sr</th>
<th>Sm</th>
<th>Nd</th>
<th>^143/144Sm</th>
<th>^146/144Nd</th>
<th>^146Nd/144Nd</th>
<th>^143Nd</th>
<th>142Nd</th>
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</thead>
<tbody>
<tr>
<td>OP-1</td>
<td>19</td>
<td>1040</td>
<td>0.052798</td>
<td>0.703081</td>
<td>± 0.09</td>
<td>-20.133</td>
<td>8.0</td>
<td>0.128723</td>
<td>0.512891</td>
<td>± 0.09</td>
<td>4.948</td>
<td></td>
</tr>
<tr>
<td>OP-2</td>
<td>20</td>
<td>1019</td>
<td>0.056722</td>
<td>0.703137</td>
<td>± 0.08</td>
<td>-19.340</td>
<td>8.2</td>
<td>0.130210</td>
<td>0.512800</td>
<td>± 0.04</td>
<td>5.124</td>
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</tr>
<tr>
<td>OP-3</td>
<td>20</td>
<td>1030</td>
<td>0.056117</td>
<td>0.703335</td>
<td>± 0.10</td>
<td>-16.529</td>
<td>7.9</td>
<td>0.130587</td>
<td>0.512891</td>
<td>± 0.03</td>
<td>4.948</td>
<td></td>
</tr>
<tr>
<td>OP-4</td>
<td>22</td>
<td>1040</td>
<td>0.061135</td>
<td>0.703105</td>
<td>± 0.10</td>
<td>-19.795</td>
<td>8.0</td>
<td>0.133702</td>
<td>0.512902</td>
<td>± 0.03</td>
<td>5.162</td>
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<tr>
<td>OP-5</td>
<td>21</td>
<td>1045</td>
<td>0.058077</td>
<td>0.703082</td>
<td>± 0.06</td>
<td>-20.121</td>
<td>8.1</td>
<td>0.125654</td>
<td>0.512601</td>
<td>± 0.05</td>
<td>-0.708</td>
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<tr>
<td>OP-6</td>
<td>34</td>
<td>875</td>
<td>0.112297</td>
<td>0.703256</td>
<td>± 0.08</td>
<td>-17.667</td>
<td>7.0</td>
<td>0.126418</td>
<td>0.512986</td>
<td>± 0.14</td>
<td>6.802</td>
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<tr>
<td>OP-7</td>
<td>13</td>
<td>510</td>
<td>0.073667</td>
<td>0.703920</td>
<td>± 0.08</td>
<td>-8.230</td>
<td>4.3</td>
<td>0.142940</td>
<td>0.512757</td>
<td>± 0.03</td>
<td>2.332</td>
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<td>OP-8</td>
<td>13</td>
<td>532</td>
<td>0.070620</td>
<td>0.703887</td>
<td>± 0.09</td>
<td>-8.698</td>
<td>4.9</td>
<td>0.148225</td>
<td>0.512675</td>
<td>± 0.07</td>
<td>0.731</td>
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<tr>
<td>OP-9</td>
<td>13</td>
<td>517</td>
<td>0.072669</td>
<td>0.703913</td>
<td>± 0.09</td>
<td>-8.329</td>
<td>5.4</td>
<td>2.442407</td>
<td>0.512721</td>
<td>± 0.04</td>
<td>1.189</td>
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<td>OP-10</td>
<td>13</td>
<td>512</td>
<td>0.073379</td>
<td>0.703916</td>
<td>± 0.10</td>
<td>-8.287</td>
<td>5.3</td>
<td>2.328679</td>
<td>0.512751</td>
<td>± 0.03</td>
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<tr>
<td>OP-11</td>
<td>12</td>
<td>946</td>
<td>0.036660</td>
<td>0.703150</td>
<td>± 0.09</td>
<td>-19.149</td>
<td>6.9</td>
<td>0.134228</td>
<td>0.512885</td>
<td>± 0.03</td>
<td>4.830</td>
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<tr>
<td>OP-12</td>
<td>13</td>
<td>965</td>
<td>0.038933</td>
<td>0.703227</td>
<td>± 0.08</td>
<td>-18.057</td>
<td>7.1</td>
<td>0.138119</td>
<td>0.512881</td>
<td>± 0.03</td>
<td>4.751</td>
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<tr>
<td>OP-13</td>
<td>12</td>
<td>944</td>
<td>0.036737</td>
<td>0.703180</td>
<td>± 0.07</td>
<td>-18.723</td>
<td>6.8</td>
<td>0.128162</td>
<td>0.512896</td>
<td>± 0.05</td>
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<tr>
<td>OP-14</td>
<td>13</td>
<td>936</td>
<td>0.040139</td>
<td>0.703176</td>
<td>± 0.08</td>
<td>-18.781</td>
<td>6.3</td>
<td>0.124967</td>
<td>0.512893</td>
<td>± 0.04</td>
<td>4.988</td>
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DISCUSSION

In this section, petrogenesis of the alkaline basalts will be discussed in detail. Most mantle-derived magmas have K$_2$O/P$_2$O$_5$ ratio of 2 or less (Basaltic Volcanism Study Project, 1981). Crustal assimilation and/or apatite fractionation can result in elevated K$_2$O/P$_2$O$_5$ ratios, as observed in the Colombia River Basalts (Carlson and Hart, 1988). The K$_2$O/P$_2$O$_5$ ratio of the samples are between 1.6 and 2.2 (except one-3.6) and the small variations in the ratios of the selected
incompatible trace elements (Zr/Nb=3.88-6.52, Zr/Ba=0.41-0.83, Y/Nb=0.36-1, Ce/Zr=0.22-0.37 and La/Zr=0.11-0.18) (see Table 1) suggest that the crustal contamination is not significant for the studied volcanic rocks along the African-Anatolian plate boundary. The studied samples have fairly large range for Ni (36-244 ppm) and Cr (146-270 ppm).

High silica samples have low Ni (36-120 ppm) and Cr (146-185 ppm) contents, compared to low silica samples that have high Ni (144-244 ppm) and Cr (237-270 ppm) respectively. This suggests that olivine and pyroxene fractionation played important role whereas plagioclase fractionation does not (absence of Eu anomaly) in affecting the compositions of the alkaline basalts in the study area.
Following these diagrams, it is suggested that the basaltic rocks were originated from asthenospheric mantle as a result of thinning of the lithosphere. Ratios of some incompatible elements such as La/Nb (0.6-0.8), Sr/Pr (107-134), Zr/Ba (0.4-0.5), Ce/Zr (0.2-0.3) suggest relatively uniform mantle source for the alkaline rocks in the study area. The differences in terms of their chondrite normalized REE and primitive mantle normalized incompatible trace element patterns suggest that they were originated from the same source under different conditions, such as different depths and different degrees of partial melting. Low ratios of Al2O3/TiO2 (5.1-6.9), fractionated HREE (Gd/Yb=2-4.1) and LREE (La/Yb=6.4-21.6) all suggest the high proportion of garnet in the residual phase during melting in the mantle source.

**CONCLUSION**

The alkaline rocks in the study area are geochemically similar to those in OIB in terms of the REE patterns and the ratios of some incompatible trace elements such as Zr/Ba, Ba/Nb, Ba/La, Zr/Nb. These intracontinental alkaline basalts resemble the alkali basalts of Basin and Range province (Fitton et al., 1991) that are interpreted as being derived from astenospheric mantle source.

The volcanic activity in the study area occurred within the transtentional zones of the NE-SW trending Yumurtalik strike-slip fault system. These NE-SW trending sinistral strike-slip fault systems controlling this volcanism have resulted from the continuous compressional tectonic regime at the Kahramanmaras triple junction (southern Turkey) where the collision of the African-Arabian and Anatolian plates occurs. The strike-slip related transtentional deformation along the African-Anatolian plate boundary might be the reason for decompresional partial melting of the astenospheric material (White and McKenzie, 1989), as basaltic lavas along this NE-SW lineament in southern Turkey.

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