

***Petrochemistry, <sup>40</sup>Ar-<sup>39</sup>Ar geochronology and Sr-Pb isotope geochemistry of the Tertiary volcanics in Eastern Pontide Southern Zone, NE Turkey: Geodynamic evolution related to slab break-off***

***and transtensional tectonics***

***Mehmet ARSLAN<sup>1</sup>, Irfan TEMİZEL<sup>1</sup>, Durmus BOZTUG<sup>2</sup>, Emel ABDIOGLU<sup>1</sup>, Hasan KOLAYLI<sup>1</sup> and Cem YUCEL<sup>1</sup>***

***Karadeniz Teknik Universitesi, Mühendislik Fakültesi, Jeoloji Mühendisliği Bölümü, 61080-Trabzon, Türkiye,***

***marслан@ktu.edu.tr <sup>2</sup>Cumhuriyet Universitesi, Mühendislik Fakültesi, Jeoloji Mühendisliği Bölümü, 58140-Sivas, Türkiye***

Eastern Pontide Tertiary Volcanic Province (T VP) shows differences in term of stratigraphical, geochemical and petrological features in northern and southern zones. The Eocene and post Eocene sequences in E-W direction are exposed as semi-isolated basin fillings in the southern zone, and overlay the Upper Cretaceous and Paleocene aged units.

The Southern Zone Eocene Volcanics (SZV) are associated with sediments (limestone, marl, siltstone, sandstone) deposited in a shallow basin environment. The volcanic rocks in the Gümüşhane and Alucra areas are mainly basalt, basaltic andesite, andesite, trachyandesite and rare rhyolite-obsidian. Petrochemically, the Gümüşhane area volcanics vary from basalt to dacite with low alkali tendency, whereas the Alucra area volcanics from basalt to basaltic-trachyandesite with high alkali tendency. The differences on the element variations of the tholeiitic-alkaline transition and calc-alkaline rocks can be explained by fractionation of clinopyroxene + hornblende + plagioclase ± magnetite ± apatite. The trace element variations show some similarities with enrichment of LILE and negative Nb, Ta and Ti anomalies. Particularly, the enrichments in LILE and a lesser extent in LREE, but the depletions in HFSE indicate that the rocks evolved from a parental magma derived from an enriched source formed by mixing of slab and asthenospheric melts. The chondrite-normalized-REE patterns of these volcanics resemble to each other and spoon-shaped with low to medium enrichment ( $La_N/Lu_N=2-35$ ), indicating similar source area for the Gümüşhane and Alucra area volcanics.

Although the rhyolite-obsidian flow, which is probably Plio-Quaternary in age, are not dated, the <sup>40</sup>Ar-<sup>39</sup>Ar dating of the Eocene andesitic and basaltic volcanics are between 37.7±0.2 and 44.5±0.2 Ma. The (<sup>87</sup>Sr/<sup>86</sup>Sr)<sub>i</sub> values of these rocks are between 0.70457 and 0.70556, and their <sup>206</sup>Pb/<sup>204</sup>Pb, <sup>207</sup>Pb/<sup>204</sup>Pb and <sup>208</sup>Pb/<sup>204</sup>Pb isotopic ratios range 18.59 to 18.73, 15.62 to 15.64 and 38.65 to 38.86, respectively. Pb- and Sr- isotopic ratios may imply that the rocks derived from a source region at the boundary of the mantle-crust, but the samples with low (<sup>87</sup>Sr/<sup>86</sup>Sr)<sub>i</sub> values (0.705) reflect the mantle source in their origin. The increasing values of SiO<sub>2</sub> (wt.%), Sr (ppm) ve (1/Sr)×10<sup>3</sup> ppm<sup>-1</sup> versus (<sup>87</sup>Sr/<sup>86</sup>Sr)<sub>i</sub> values suggest fractional crystallisation (FC) rather than assimilation (AFC) in their evolution.

Based on geochemical, petrological and evolutionary characteristics of Tertiary period volcanics, it is suggested that Pontides have similar features of thickening continental crust and the subduction-imposed thermal structure was very important in the generation of magmatism. Tertiary volcanism may be the product of continental equivalent of tensional events developed during Eocene and following time in which tensional regime was the most effective and thus opening stage was very fast during the opening of Black Sea. Moreover, it may be suggested that especially E-W directed Eocene volcano-sedimentary basins are transtensional (basin type developed under tension and effective strike slip faulting at the same time) basins formed by tensional regime that caused fast opening of Black Sea. In the region, subparallel deep faults (large transtensional faults and strike-slip movements) may have formed in Tertiary during late stage collision and post-collision under intensive influence of geodynamic regimes. Thus, it is thought that the extensional regime resulted in approximately E-W trending basins and subsequent calc-alkaline and tholeiitic-alkaline transition volcanism in the south. Mainly calc-alkaline nature of SZV connected with that fact which occurred by increasing geodynamic regime-compression after slab break off whereas transitional to mildly

alkaline nature is due to local variation in extension, thermal structure and thickness of crust and mantle-crust source regions. Based on volcanic variety and distributions together with petrological data, volcanic activity in the Tertiary time of the eastern Pontide is closely related to the thinning of young lithosphere caused by transtensional extensional regime developed by slab break-off in the Pontide palaeo-magmatic arc during Upper Cretaceous-Eocene time. *Keywords: Volcanism, petrology, geochemistry, geodynamic evolution, Pontides*

Dogu Pontid Giiney Zonu (KD Tiirkiye) Tersiyer volkanitlerinin petrokimyasi,  $^{40}\text{Ar}$ - $^{39}\text{Ar}$  jeokronolojisi ve Sr-Pb izotop jeokimyasi: Litosferik dilim kopmasi ve transtansiyonel tektonik ile iliřkili jeodinamik geliřim

Dogu Pontid Tersiyer Volkanik Provensi (TVP) kuzey zon ve gúney zonda stratigrafik, jeokimyasal ve petrolojik bakımından farklılıklar göstermektedir. Yaklasik D-B dogrultulu yari izole havza dolgulari olarak yilzeylenen Eosen ve Eosen sonrası yasli istif, list Kretase ve Paleosen birimlerinin úzerine gelmektedir.

Gúney Zonu Eosen Volkanitlerine (GZV) tabanda ve ara seviyeler halinde sig denizel tortul birimler (kirectasi, marn, silttasi, kumtasi) eslik etmektedir. Giimiishane ve Alucra yoresinde volkanik kayalar, genelde bazalt, bazaltik andezit, andezit, trakiandezit ve nadiren riyolit-obsidiyen tilril kayalardan olusmaktadır. Petrokimyasal olarak, Giimiishane yoresi volkanitler, bazalttan dasitik bileşime kadar deęiserek diisik alkali egilime sahipken, Alucra yoresi volkanitler bazalttan trakiandezite kadar deęisen bileşimde yilsek alkali egilim gosterirler. Toleyitik-alkali gecisli ve kalkalkali kayalardaki element deęisimleri; bazaltik kayalarda klinopiroksen  $\pm$  magnetit ayrimlasmasi, andezitik kayalarda ise hornblend + plajiyoklas  $\pm$  magnetit  $\pm$  apatit ayrimlasmasi ile aciklanabilir. Iz element dagilimlan birbirine benzer olup, bilyilk iyon yancapli elementlerde (LILE) zenginlesme ve negatif Nb, Ta ve Ti anomalileri gozlenmektedir. Ozellikle LILE zenginlesmesi (Sr,  $\text{K}_2\text{O}$ , Rb, Ba) ve daha az oranda hafif nadir toprak elementler (LREE) bakımından zenginlesme ve yilsek cekim alanli elemenler (HFSE) bakımından tüketilme, volkanitlerin yitim ve astenosferik ergiyiklerin kanstigi zenginlesmis bir koken magmadan tilreyebileceklerini ifade etmektedir. Kondrite gore normalize edilmiş nadir toprak element dagilimları, duřuk-orta derecede zenginlesmeyle ( $\text{La}_\text{N}/\text{Lu}_\text{N}=2-35$ ) birbirlerine benzer ve kasik sekilli olup, koken olarak Gumtishane ve Alucra yoresi volkanitlerinin benzer kaynaklardan itibaren olustugunu diisundiirmektedir.

Pliyo-Kuvaterner yasli oldugu dusiiniilen riyolit-obsidiyen tilril kayalarda mutlak yaslandirma olmamasma ragmen, Eosen andezitik ve bazaltik volkanitlerin  $^{40}\text{Ar}$ - $^{39}\text{Ar}$  yaslandirmasi,  $37.7\pm 0.2$  My ile  $44.5\pm 0.2$  My arasmdadir. ( $^{87}\text{Sr}/^{86}\text{Sr}$ ); deęerlen  $0.70457-0.70556$  arasmdadir.  $^{206}\text{Pb}/^{204}\text{Pb}$  oranlari  $18.59-18.73$ ,  $^{207}\text{Pb}/^{204}\text{Pb}$  oranlari  $15.62-15.64$  ve  $^{208}\text{Pb}/^{204}\text{Pb}$  oranlari ise  $38.65-38.86$  arasinda deęismektedir. Pb ve Sr izotop bileşimleri, kayagların manto-kabuk simrında bir bolgeden tilredigine isaret etmekle birlikte ozellikle ( $^{87}\text{Sr}/^{86}\text{Sr}$ )i  $< 0.705$  olan orneklerin tipik olarak manto karakterini yansittiklari soylenebilir. Aynca, artan  $\text{SiO}_2$  (%), Sr (ppm) ve  $(\text{l}/\text{Sr})\times 10^3$  ppm<sup>1</sup> deęerlerine karsi ( $^{87}\text{Sr}/^{86}\text{Sr}$ )i deęerlerinin yataya yakm bir yonseme sunmasi, kayagların gelişiminde asimilasyon (AFC) daha ziyade fraksiyonel kristalllesmenin (FC) daha etkili oldugunu gostermektedir.

Tersiyer donemi volkanitlerinin jeokimyasal, petrolojik ve gelişim ozelliklerine dayamlarak Pontidlerin, kalmlasan kitasal kabuk bileşimine yakm bir ozellige sahip oldugunu, yitim sonrası lsisal yapmm magmatizmanın gelişimi ağısmdan 90k önemli oldugunu soylemek mtlmktlndtır. Tersiyer volkanizmasi, Karadeniz'in ağılmasi sirasmda gerilme rejiminin en etkin oldugu ve dolayisiyla acilmamn en hizli oldugu Eosen zamamndaki gerilmelerin kitadaki esdeęerlerinin tlrntl olarak dilsilnillebilir. Ozellikle D-B uzammlı Eosen volkano-sedimanter havzalarım, Karadeniz'in acihsim hizlanmasma yol aęan gerilme rejimine baęh olarak meydana gelen transtansiyonel (gerilme sirasmda aym zamanda dogrultu atimli faylanmamn da etkin olması nedeniyle olusan havza tipi) havza olduklarım soylemek mumkundır. Bolgede, Tersiyer doneminde yogun jeodinamik rejimlerin etkisi altında garpismamn son asamasmada ve garpisma sonrasmda birbirine yari paralel derin fayların (bilyilk transtansiyonel ve dogrultu atimli faylar) gelişmesi mtlmkilndtır. Bu yilzden, bu ekstansiyonel rejimin, giiney zonda yaklasik D-B uzanlı havzaların olusumuna ve

yaygın kalkalkali ve toleyitik-alkali gegis karakterli volkanizmaya neden oldugu dtlstntlmektedir. GZV'nin baskin kalkalkalin dogasi, slab break off mekanizmasmdan sonra gerilme olaylarıyla ardalananan sikisma jeodinamik rejiminin giderek artmasiyla, buna karsm gegis-hafif alkali dogasi ise gerilme rejiminde, kabugun Isısal yapisi-kalmligi ve manto-kabuk kaynak bolgesindeki lokal degisimlerle iliskilendirilebilir. Volkanik cesitlilik ve dagilim petrolojik verilerle birlikte degerlendirildiginde, Dogu Pontid Tersiyer volkanizmasinm, Ust Kretase-Eosen zamanında Pontid eski magmatik yaymda litosferik dilim kopmasma (slab break-off) bagh transtansiyonel gerilme rejimiyle olusan litosferin incelmesiyle iliskili oldugu dusilnilmektedir. *Anahtar Kelimeler: Volkanizma, petroloji, jeokimya, jeodinamikgeligim, Pontidler*