# Evidence on mixing of mantle and crustal derived magmas in Bodrum (Mugla) area volcanic rocks, Southwest Turkey

M. Arslan — Dept. of Geology, Karadeniz Technical University, Trabzon, Turkey

H. Kurt — Dept. of Geology, Selçuk University, Konya, Turkey

I. Kayabali — Directorate of Mineral Research and Exploration, Ankara, Turkey

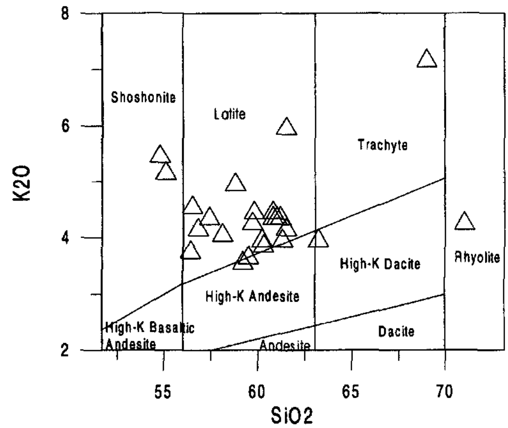
The study area is located at Turgutreis-Ortakent-Yalikavak-Akyarlar areas, the west of Bodrum (Mugla) in the Southwest Turkey where calcalkaline, alkaline and locally shoshonotic volcanism were effective after the end of Middle Miocene. These volcanics has been attributed to continental rifting due to tensional regime (e.g. Ercan *et al.*, 1984). Tensional tectonics in the region affected thickened and partially melted continental crust, and caused the mixing of crustal calcalkaline- and mantle derived alkaline magmas. Two volcanic cycles were effective in the Bodrum Peninsula during Middle-Upper Miocene times. First cycle volcanites are tuff-agglomerate, high-K calcalkaline andesite-dacite-rhyodacite-rhyolite suite developed at the end of Middle Miocene. This cycle ceased with shoshonitic latite and trachyandesite, and second cycle developed with shoshonitic basalt, trachybasalt and trachyte as small outcrops and dykes in Upper Miocene (Ercan *et al.*, 1984).

The volcanites studied, namely andesite, latite, dacite, rhyodacite and rhyolite (Fig. 1), show generally porphyric and sometimes felsitic, hyalopilitic, microlitic, pilotaxitic textures. Pheno- and microphenocrystals are plagioclase, biotite, hornblende, quartz, augite and sanidine. Groundmass is made up generally by feldspar microlites and/or glass, and sometimes alteration products.

Plagioclases are subhedral laths and rarely resorbed and fragmented crystals. Some of them commonly display sieve texture with mottled extinction or patchy zoning, and inclusions of pale grown glass, sometimes with an overgrowth rim which may be separated from the cores by a dark grey zone of 'clouded' plagioclase charged with micron-sized melt inclusions. Plagioclases also show discontinuous and sometimes oscillatory zoning. Hornblendes are subhedral to anhedral, but often 'ghost like' crystals, pseudomorphed by opaques, pyroxene, feldspars and quartz or simply rimmed by opaques. Biotites are subhedral to anhedral with common reaction rims or breakdown products, or pseudomorphed by opaques. Breakdown of biotite forms opaques or a granular intergrowth of opx + ilmenite + magnetite + K-feldspar. These reaction products of hornblend and biotite were caused by dehydration above the hornblend and biotite stability limit as result of magma mixing (e.g. Nixon, 1988).

The rocks are generally high-K calcalkaline in composition, having 4–7% $K_2O$ (Fig. 1), 15.8–17.8% $Al_2O_3$, 26.3–47.1 Mg-number, low Ni, Cr, Co and high La, Ce contents.

Furthermore low $Na_2O/K_2O$, Nb, $TiO_2$ (<1%) and high LILE contents resembles volcanites developed at active continental margins. Geochemical variations show that the rocks are cogenetic and related to each other by fractional crystallisation, assimilation and magma mixing processes during the evolution of crustal magma chambers. Major and trace element variations can be explanied by fractionating phenocrystal phases. Low Y and high La/Y may imply that




.FIG. 1. $SiO_2$ *vs* $K_2O$ plot of the rocks. Fields are from Peccerillo and Taylor (1976).

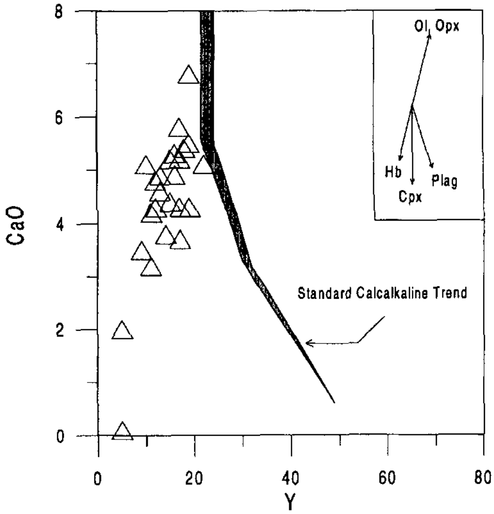



FIG. 2. CaO *vs* Y plot (after Lambert and Holland, 1974). The inset shows qualitative trends of fractionation.

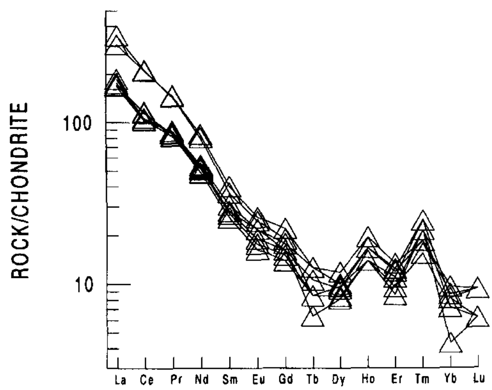



FIG. 3. Chondrite (Boynton, 1984) normalized *REE* patterns of the rocks.

garnet did not played an important role as fractionating or residual phase in source magma. Furthermore, decreasing Y contents (22 to 5 ppm) with a J-type trend (Fig. 2) suggest a significant hornblend controlled fractionation in the evolution of the rocks.

The rocks exhibit highly fractionated *REE* patterns with $(La/Lu)_{CN}$=20–50 (Fig. 3). *LREE* enrichment is significant relative to *MREE* and *HREE*, exhibiting concave upward pattern which also supports the hornblend fractionation. However, high $SiO_2$, LILE content may reflect that parental magma interacted with crustal materials during differantiation, possibly as assimilation during magma ascent or AFC. The effect of crustal component increases towards acidic compositions. Depletion in Nb and $TiO_2$ may generally be related to accessory phase during partial melting under hydrous conditions.

Conclusively, disequilibrium textures and geochemical data obtained suggest that the parental magma of the rocks formed by mixing of the mantle derived basaltic and crustal magmas, and then evolved by hornblende-dominated fractionation in a crustal magma chamber. Hence hornblend fractionation requires high pressure and water content (e.g. Eggler and Burnham, 1973), the parental magma had therefore high water content (>2%) and probably undergone differentiation in lower-middle crustal magma chamber (3–15 kb).

## References


Boynton, W.V., (1984) *Rare Earth Element Geochemistry*, Elsevier, 63–114.

Eggler, D.H. and Burnham, C.W. (1973) *Geol. Soc. Amer. Bull.*, **84**, 2517–32.

Ercan, T., Türkecan, A. and Günay, E. (1984) *Geol. Bull. Turkey*, **27**, 85–98 (in Turkish).

Lambert, R.S.J. and Holland, J.G. (1974) *Geochim. Cosmochim. Acta*, **38**, 1393–414.

Nixon, G.T. (1988) *J. Petrol.*, **29**, 213–64.

Peccerillo, A. and Taylor, S.R. (1976) *Cont. Mineral. Petrol.*, **58**, 63–91.