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ORIGINAL PAPER

Petrochemistry and petrology of I-type granitoids in an arc setting: the composite Torul pluton, Eastern Pontides, NE Turkey

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Abstract The Upper Cretaceous Torul pluton, located in the Eastern Pontides, is of sub-alkaline affinity and displays features typical of volcanic arc granitoids. It is a composite pluton consisting of granodiorite, biotite hornblende monzogranite, quartz monzodiorite, quartz monzonite and hornblende biotite monzogranite. The oldest syenogranite (77.9 ± 0.3 Ma) and the youngest quartz diorite form small stocks within the pluton. Samples from the granodiorites, biotite hornblende monzogranites, quartz monzodiorites, quartz monzonites and hornblende biotite monzogranites have SiO_2 between 57 and 68 wt% and display high-K calc-alkaline, metaluminous to peraluminous characteristics. Chondrite-normalized REE patterns are fractionated (La_{cn}/Lu_{cn} = 6.0–14.2) with pronounced negative Eu anomalies (Eu/Eu* = 0.59–0.84). Initial $\varepsilon_{Nd(i)}$ values vary between –3.1 and –4.1, initial $^{87}Sr/^{86}Sr$ values between 0.7058 and 0.7072, and $\delta^{18}O$ values between +4.4 and +7.3‰. The quartz diorites are characterized by relatively high Mg-number of 36–38, low contents of Na_2O (2.3–2.5 wt%) and SiO_2 (52–55 wt%) and medium-K calc-alkaline, metaluminous composition. Chondrite-normalized REE patterns are relatively flat [$(La/Yb)_{cn}$ = 2.8–3.3; $(Tb/Yb)_{cn}$ = 1.2] and show small negative Eu anomalies (Eu/Eu* = 0.74–0.76). Compared to the other rock types, radiogenic isotope signatures of the quartz diorites show higher $^{87}Sr/^{86}Sr$ (0.7075–0.7079) and lower $\varepsilon_{Nd(i)}$ (–4.5 to –5.3). The syenogranites have high SiO_2 (70–74 wt%) and display high-K calc-alkaline, peraluminous characteristics. Their REE patterns are characterized by higher La_{cn}/Lu_{cn} (12.9) and Eu/Eu* (0.76–0.77) values compared to the quartz diorites. Isotopic signatures of these rocks [$\varepsilon_{Nd(i)}$ = –4.0 to –3.3; $^{87}Sr/^{86}Sr_{(i)}$ = 0.7034–0.7060; δ^{18} O = + 4.9 to + 8.2] are largely similar to the other rock types but differ from that of the quartz diorites. Fractionation of plagioclase, hornblende, pyroxene and Fe–Ti oxides played an important role in the evolution of Torul granitoids. The crystallization temperatures of the melts ranged from 800 to 900°C as determined from zircon and apatite saturation thermometry. All these characteristics, combined with low K_2O/Na_2O, low $Al_2O_3/(FeO_T + MgO + TiO_2)$, and low $(Na_2O + K_2O)/(FeO_T + MgO + TiO_2)$ ratios suggest an origin through dehydration melting of mafic lower crustal source rocks.

Keywords Composite Torul pluton · Eastern Pontides · Granitoid · Isotope systematic · Petrogenesis

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Introduction

Granitoid plutons are essential constituents of collision belts. They are characterized by a large compositional diversity arising from different source compositions, vari-