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Petrology and petrogenesis of Kighal-Barmolk Porphyry Stock (North of Varzeghan, East Azarbaidjan Province, NW Iran)

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Quartz monzonitic porphyry stock of Kighal-Barmolk is located in ∼12 km north of Varzeghan, East-Azarbaidjan province of Iran. Geologically this area is a part of volcano-plutonic zone of Alborz-Azarbaidjan. The porphyry stock intruded upper Eocene andesitic-latitic and andesitic-basaltic units during magmatic activities of Pyrenean orogenic phase (upper Oligocene-lower Miocene) and its hydrothermal activities coupled with boiling caused shattering and hydro-fracturing within the cupola leading to the development of various kinds of pervasive alteration zones such as potassic, phyllic, argillic, advanced argillic and propylitic. After its emplacement and during Miocene period, 3 other barren sub-volcanic bodies have intruded into porphyry stock and peripheral host rocks, with granodioritic, microdioritic and monzonitic compositions, respectively, which haven't produced any hydrothermal alteration and mineralization. Additionally, numerous cross-cutting dikes ranging in composition from diorite-quartz diorite to granodiorite, microdiorite and monzodiorite, have intruded into porphyry stock.
The porphyry stock and cross-cutting dykes belong to I-type magnesian granitoids and show calc-alkaline to shoshonitic nature and meta-aluminous to per-aluminous characteristics, which can be due to high crustal contamination.
Based on the oxide-oxide diagrams (Harker, 1909), it is apparent that cross-cutting dykes and porphyry stock have a common source for their parental magma. Furthermore, there are obvious mineralogical variations among the dyke suites, proportional to their order of intrusion, as the first generation dykes (qd1) are more felsic and toward to (qd2) and (qd3), (md) and (mzd) dyke suites, the composition gradually becomes more basic and the silica content decreases.
The REE patterns of cross-cutting dykes and porphyry stock in spider diagrams are also similar, which can confirm the presence of a common source for their parental magma and occurrence of differentiation within the magma chamber. The relatively negative anomaly of Eu (Eu/Eu*=0.7-1.01; McDonough and Sun, 1995) along with slightly descending trend of REEs from LREE toward HREE, can be due to fractional crystallization of Ca-rich plagioclase, relatively higher ratio of high fCO2/ fH2O, and presence of garnet in source rocks of the parental magma.
In primitive mantle-normalized spider diagram of trace and rare earth elements (based on normalizing values of McDonough and Sun, 1995), there are obvious positive anomalies of Cs, Pb, K, Mo and U and negative anomalies of Nb and Ti, which is characteristic of intrusive bodies emplaced in continental arc settings (Wang et al., 2004 [U+061B] Richards et al., 2001). This pattern is also indicative of calc-alkaline magmas.
Additionally, there is a strong similarity between the pattern of trace and rare earth elements in the ORG-normalized spider diagram (based on normalizing values of Pearce et al., 1984) and the pattern of intrusive bodies emplaced in volcanic arcs of active continental margins such as Jamaica and Chile and indicates the emplacement of parental magma within thick continental crust, causing its partial melting and occurrence of crustal contamination, which has been referred as crustal dominance by Harris (1983). Tectonically, these rocks are affiliated to post-collisional volcanic arcs of active continental margin.

Key words: Kighal-Barmolk, Quartz monzonite porphyry, Calc-alkaline, Cross-cutting dykes, post-collisional volcanic arc.