



## The petrological and geochemical study of granitoid rocks from Mashhad area, Iran: Evidence for the Late Triassic Collisional Belt Northeast of Iran

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Mashhad granitoid complex is part of the northern slope of the Binalood Structural Zone (BSZ), Northeast of Iran, which is composed of granitoids and metamorphic rocks. This research presents new petrological and geochemical whole-rock major and trace elements analyses in order to determine the origin of granitoid rocks from Mashhad area. Field and petrographic observations indicate that these granitoid rocks have a wide range of lithological compositions and they are categorized into intermediate to felsic intrusive rocks ( $\text{SiO}_2$ : 57.62-74.39 Wt.%). Quartzdiorite, tonalite, granodiorite and monzogranite are common granitoids with intrusive pegmatite and aplitic dikes and veins intruding them. Based on geochemical analyses, the granitoid rocks are calc-alkaline in nature and they are mostly peraluminous. On geochemical variation diagrams (major and minor oxides versus silica)  $\text{Na}_2\text{O}$  and  $\text{K}_2\text{O}$  show a positive correlation with silica while  $\text{Al}_2\text{O}_3$ ,  $\text{TiO}_2$ ,  $\text{CaO}$ ,  $\text{Fe}_2\text{O}_3$ , and  $\text{MgO}$  show a negative trend. Therefore fractional crystallization played a considerable role in the evolution of Mashhad granitoids. Based on the spider diagrams, there are enrichments in LILE and depletion in HFSE. Low degrees of melting or crustal contamination may be responsible for LILE enrichment. Elements such as Pb, Sm, Dy and Rb are enriched, while Ba, Sr, Nd, Zr, P, Ti and Yb (in monzogranites) are all depleted. LREE enrichment and HREE depletion are observed in all samples on the Chondrite-normalized REE diagram. Similar trends may be evidence for the granitoids to have the same origin. Besides, LREE enrichment relative to HREE in some samples can indicate the presence of garnet in their source rock. Negative anomalies of Eu and Yb are observed in monzogranites. Our results show that Mashhad granitoid rocks are orogenic related and tectonic discrimination diagrams mostly indicate its syn-to-post collisional tectonic setting. No negative Nb anomaly compared with MORB seems to be an indication of non-subduction zone related magma formation. According to the theory of thrust tectonics of the Binalood region, the oceanic lithosphere of the Palo-Tethys has subducted under the Turan microplate. Since the Mashhad granitoid outcrops are settled on the Iranian plate, this is far from common belief that these granitoid rocks are related to the subduction zones and the continental arcs. The western Mashhad granitoids show more mafic characteristics and are possibly crystallized from a magma with sedimentary and igneous origin. Thus, Western granitoid outcrops in Mashhad are probably hybrid type and other granitoid rocks, S and SE Mashhad are S-type. Evidences suggest that these continental collision granitoid rocks are associated with the late stages of the collision between the Iranian and the Turan microplates

during the Paleo-Tethys Ocean closure which occurred in the Late Triassic.