



Geochronology and Lu-Hf isotopic study of the granodioritic pulse in the Qaradagh batholith (NW Iran)

Vartan Simmonds¹, Mohssen Moazzen², Gültekin Topuz³, and Ali Mohammadi⁴

¹University of Tabriz, Faculty of Natural Sciences, Earth Sciences Department, Tabriz, Iran, Islamic Republic of (simmonds_vartan@yahoo.co.uk)

²University of Tabriz, Faculty of Natural Sciences, Earth Sciences Department, Tabriz, Iran, Islamic Republic of

³Istanbul Technical University, Eurasia Institute of Earth Sciences, 34469, Istanbul, Turkey

⁴ETH Zurich, Department of Earth Sciences, Sonneggstrasse 5, 8092, Zurich, Switzerland

The Qaradagh batholith in northwest Iran mainly comprises granodioritic rocks, which makes more than 50% of the batholith. This lithology is the first intrusive pulse within this batholith and the oldest Tertiary magmatism in the region, though other younger pulses of granite, diorite, quartz-diorite, syenite, quartz-syenite, monzonite, quartz-monzonite, quartz monzodiorite, monzogranite and gabbro intruded the main body. These magmatic rocks have intruded the Upper Cretaceous and Paleogene sedimentary, volcano-sedimentary and igneous rocks.

The Qaradagh batholith hosts vein-type and some local stock-work type Cu-Au-Mo mineralization, especially in its central parts, while skarn-type deposits have been formed at its contacts with peripheral carbonate rocks. Its extension towards the north into the neighboring south Armenia (which is part of the South Armenian Block) is known as the Meghri-Ordubad pluton (MOP), which hosts several large porphyry Cu-Mo deposits and other precious and base metal mineralizations. U-Pb geochronology on the zircons separated from the granodioritic unit yielded a weighted ²⁰⁶Pb/²³⁸U mean age of 43.81 ± 0.18 (MSWD=1.38) and a Pb*/U concordia age of 44.04 ± 1.00 Ma (MSWD= 24), which correspond to Middle Eocene.

Since the Qaradagh batholith and especially its earliest magmatic phase are considered as the oldest plutonic event of the Cenozoic age in northwest Iran, thus this investigation testifies to the fact that intrusive activities of Tertiary in this region has commenced in Middle Eocene, contrary to the opinion of the majority of authors who believe that plutonism in this region occurred during Oligocene.

However, this age is much older than the molybdenite Re-Os ages of quartz-sulfide veins hosted by granodioritic rocks (25.19 ± 0.19 to 31.22 ± 0.28 Ma), indicating that mineralization in this batholith is related to another much younger intrusive phase, and even to several phases, as the published ages of molybdenites from various veins and mineralized zones show a large interval. Comparing the obtained age with those from the MOP in southern Armenia indicate that southern part of the MOP is almost coeval with the emplacement of the granodioritic rocks in Qaradagh batholith.

The U and Th contents of the zircons range from 17.1 to 1534.0 and from 4.9 to 641.0 ppm, respectively, with Th/U ratios between 0.66 and 5.82 (mean of 1.26), indicating a magmatic source. Meanwhile, the $\epsilon_{\text{Hf}(t)}$ values of the zircons range from 8.7 to 11.1 with the mean of 9.5, which are plotted between the CHUR and the Depleted Mantle evolution lines, indicating a juvenile and homogeneous magmatic source and the predominance of mantle-derived magmas with limited crustal assimilation.