



Gharebagh Intrusive Complex: Evidence of Tethyan magmatic activity in NW Iran

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The Gharebagh intrusive complex (GIC) is hosted within the northernmost part of the Zagros orogenic system in NW Iran which is the Iranian part of the Tethyan orogenic collage. It was formed by the NE-ward subduction of Neo-Tethyan oceanic lithosphere and the subsequent continental collision between Gondwana and Eurasia. GIC is now part of the collisional plate boundary of the Alpine-Zagros-Himalayan orogenic belt in the Middle East region. This intrusive complex provides a unique opportunity to study the magmatic activity along with the formation of Paleotethys and Neotethys. With about 200 km² in size it consists of a suite of mafic to acidic rocks which intruded into Precambrian metamorphic rocks. The study of the petrology, isotope chemistry (Lu-Hf and Sm-Nd) and geochronology (LA-ICP MS U-Pb zircon dating) of these rocks enabled to constrain their origin and tectonic setting for first time in this part of Iran.

Based on U-Pb zircon dating two stages of magmatic activity can be distinguished. The first stage is presented by a Precambrian peraluminous leucogranite with an age of 558.6 ± 3.8 Ma. Its emplacement is related to the opening of the Paleotethys Ocean in this region. The second stage at ~ 300 Ma is related with a suite of mafic to acidic rocks, implying that they were formed in the Late Paleozoic, during the opening of the Neotethys Ocean.

Isotope analyses of the leucogranite shows an initial $\epsilon_{\text{Nd}}(t)$ value of -4.3 with $T_{DM} 1.61$ which indicates the melting of a juvenile crustal protolith. The Th/U value of the zircons indicates the involvement of both crustal and mantle components. This suggests that the leucogram was generated by partial melting of Paleoproterozoic lower crustal rocks of the Arabian Shield, presumably during the opening of the Paleotethys Ocean at the primary stages of the evolution of Gondwana and Eurasia.

The second stage at ~ 300 Ma was formed during the northward opening of the Neotethys in Iran along the northern part of Zagros orogenic belt. Crustal-model ages (Hf- t_{NC}) of 0.57 to 1.02 Ga indicate the contribution of an older continental Neoproterozoic crust in the formation of the Gharebagh intrusive complex. Based on Lu-Hf and Sm-Nd isotopes, we conclude that the suite of mafic to acidic magma were derived by partial melting of the depleted mantle, mixed with different proportion of melted lower crust.

Therefore, based on the new age information and the tectonic setting of GIC, we conclude that this section was originally part of the Peri-Gondwanan terranes. According to the Neoproterozoic-early Cambrian intrusion activity recorded by the leucogranite, one part of the Gondwanan block was separated from the Arabian Shield with the opening of the Paleotethys. This "Iranian" block joined with Eurasia by subsequent closing of the Paleotethys. The Gharebagh intrusive complex indicates the opening of the Neotethys Ocean in this region during the final stages of the evolution of the Gondwana and Eurasia in late Paleozoic.