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Geochemistry and tectonic setting of the Golabad granitoid complex (SW Nain, Iran)

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ABSTRACT

The Oligo-Miocene Golabad granitoid complex intrusive into the Eocene volcanic rocks occurs in the Urumieh-Dokhtar Magmatic Arc (UDMA) in Iran. According to microscopic and chemical studies, the granitoid complex consists of three different rock types: 1) plutonic rocks comprising diorite, quartz diorite, granodiorite and granite; 2) volcanic rocks composed of basalt, andesite basalt, ± pyroxene bearing andesite and rhyolite, and 3) pyroclastic rocks. The main mineral constituents of these rocks are mostly plagioclase (oligoclase and andesine), quartz, K-feldspar, amphibole (magnesio-hornblende and actinolite-hornblende) and Mg-biotite. In addition, apatite, titanite, zircon, and opaque minerals are common accessory minerals. The studied enclaves are classified as mafic micro-granular enclaves (MME) with monzodiorite compositions. Geochemically, the rocks in this study represent medium to high-K calc-alkaline series, metaluminous and I-type nature.

Plotting, the chemical composition of plagioclase on the An-Ab-Or ternary diagram, the temperature of crystallization is estimated to range from 700 to 900 °C at a pressure of 4.5 Kbar. High TiO_2 values of biotites from the Golabad granitoid complex suggest magmatic origin and the crystallization temperature is estimated to range from 700 to 750 °C. The amphiboles according to their chemical analysis, are classified as igneous amphiboles generated in high oxygen fugacity conditions. The chemical data of the amphiboles and biotites pointed out to the I- type nature of the Golabad granitoid complex emplaced in an active continental margin subduction setting. The amphibole crystallization pressure was estimated by Al in amphibole varies from 1.09 to 2.28 Kbar. Using the calculated pressure the depth of the formation of the Golabad granitoid complex estimated from 4 to 9 Km.

1. Introduction

The collision of the Eurasian plate and the Afro-Arabian plate during the late Mesozoic and Cenozoic formed the Urumieh-Dokhtar Magmatic Arc (UDMA) (Richards and Sholeh, 2016). The UDMA along with the Sanandaj-Sirjan zone and the Zagros folded-thrust belt are the three main geological subdivisions of the Zagros orogenic belt (Alavi, 2004). The UDMA is the result of the several events including opening, subduction and closure of the Neo-Tethys Ocean. Carboniferous and Permian plutonic events in Sanandaj-Sirjan zone are considered related to the rifting and formation of the Neo-Tethys (see in Alavi, 1994). Some workers believe that the tectonic setting of UDMA is related to the continental rift (Emami, 1981; Sabzehei, 1994) whereas, others believe that its tectonic setting is associated with a subduction zone (Berberian and Berberian, 1981). Some geologists suggested that the calc-alkaline magmatism ended around 5 Ma (Late Miocene) and was replaced by alkaline magmatism associated with slab break-off (Ghasemi and Talbot, 2006; Honarmand et al., 2014). The Eocene volcanism in Iran and throughout the Middle East and the Mediterranean regions is related to the opening of back-arc basins (Kazmin et al., 1986). The beginning of most of the magmatic activities in UDMA occurred in the Eocene and continued in Middle Eocene until Plio-Quaternary formed a variety of igneous rocks (Berberian and Berberian, 1981; Ghasemi and Talbot, 2006; Torabi, 2009). Therefore, these features are the reasons for studies and investigations of this zone (UDMA) by researchers. The study area is part of the 1:250000 geological map of Nain prepared by Amidi and Alavi (1978). Mansouri Esfahani and Norbehesht (1997) studied the

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geology and petrology of the granitoid intrusions of the southwest of the Nain area. Amidi (1975) studied stratigraphy, petrology and geochemistry of Surk-Nain-Natanz and believed that the mainrocks belong to Pliocene volcanism. Javanmardi and Davoudian (2009) recognised the pumpellyite-prehnite- quartz rock assemblages as an important metamorphic facies in the north east of the Kohpaeh volcanic rocks (east of Isfahan city). Jahanbakhsh (2014) carried out geochemical and petrological studies on the Golabad intrusive body in the southwest of Nain. He believed that this intrusive body is I-type and shows calc-alkaline nature.

The aim of this study is to determine the geochemistry, tectonic setting and the role of magma mixing in the generation and evolution of the Golabad granitoids in the Nain area. The research is supported by petrographical and geochemistry observations as well as the mineral chemistry analysis of plagioclase, amphibole and biotite.

2. Geological setting

The Golabad granitoid complex is located about 100 Km east of Isfahan, 40 Km southwest of Nain city and geologically it lies in the central part of the UDMA (Fig. 1A). The area is cut by the Qom-Zefreh and Dehshir-Baft faults (Fig. 1B). These faults trend in an NE-SW direction. Several outcrops of plutonic rocks are related to these faults or other subsidiary faults associated with these two main faults (Fig. 1A).

The oldest sedimentary rocks in the eastern corner of the studied area present nearly small outcrops of conglomerate layers with the Paleocene age. The Eocene volcanic rocks which cross-cutting by the Oligo-Miocene granitoid body, consist of basalt, andesite-basalt, ± pyroxene bearing andesite, trachyte, dacite and rhyolite (Fig. 1C). The Eocene meta-andesite and meta-basaltic rocks observed in proximity to the Golabad granitoid complex. These rocks are related to the granitoid intrusion and development of a contact metamorphism with a low-grade albite-epidote hornfels facies (Fig. 2A). Most of the volcanic rocks are located in the northern and eastern parts of the plutonic rocks. The basalt outcrops are mostly located in the northern portion of the plutonic rocks which show fine-grained and grey to dark green in colour. While rhyolitic rocks mostly display a dome shape in the west and the southwest of the Golabad granitoid complex. The components of the pyroclastic rocks are widely dominated by rhyolite, dacite and andesite which mostly seen in northern and southern part of the studied area. They mostly trend in an NW-direction. Numerous diabasic and aplite dykes crosscut the pyroclastics as well as the Golabad granitoid complex (Fig. 2B and C). The Pliocene conglomerates with intercalation of sandstone layers are the main sedimentary rocks of the studied area. Microgranular mafic enclaves

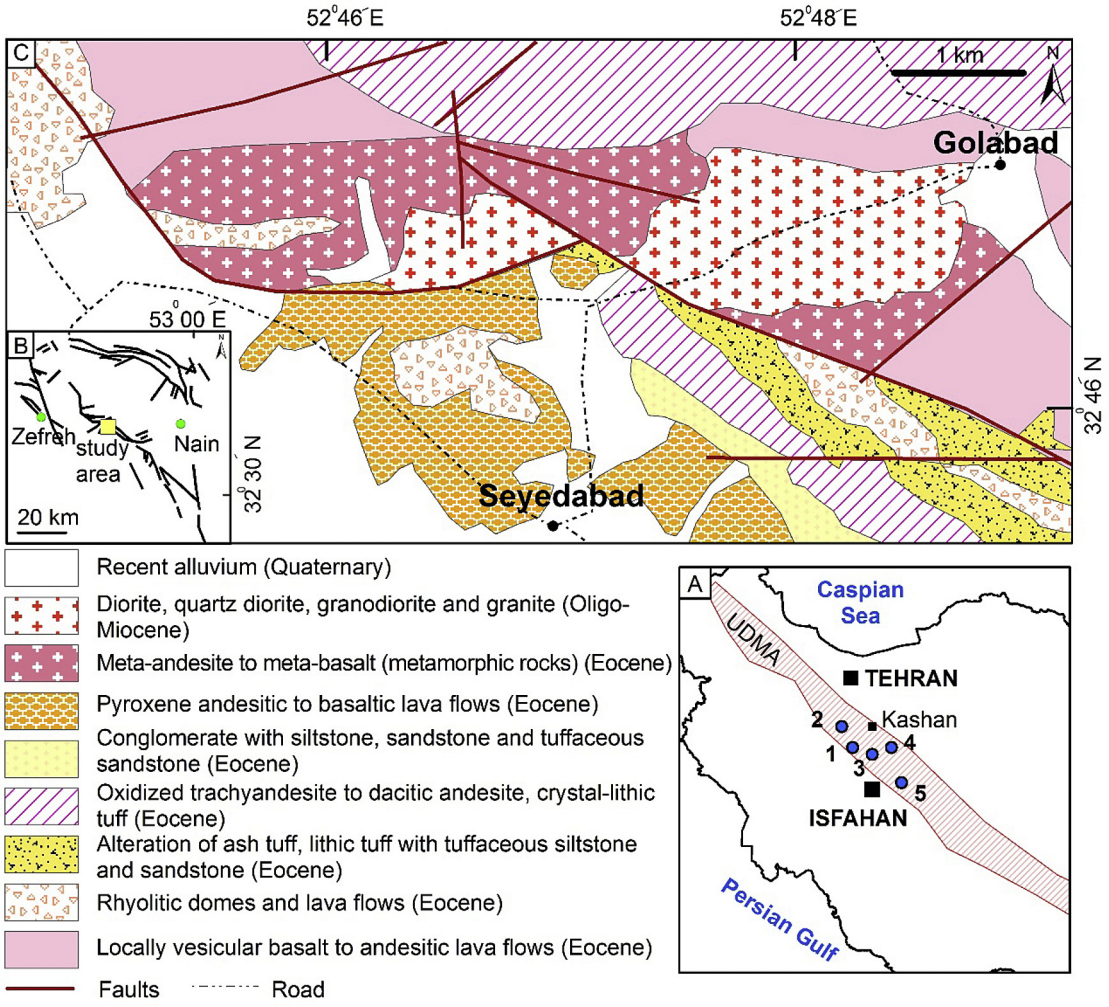

Fig. 1. (A) The geological situation of the Urumieh-Dokhtar magmatic arc (UDMA); the location of granitoid complexes is shown as: 1-Nabar, 2-Niyasar, 3-Ghohroud, 4-Natanz and 5-Golabad; (B) The major faults in the Golabad granitoid area; (C) Simplified geological map of the studied area (modified after Emami, 1981).