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Petrology, Geochemistry and Tectonomagmatic Setting of Farmahin Volcanic Rocks (North of Arak)

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Introduction

The study area includes Alam Baghi, Vashaghan, Sar Band and Ghermez Cheshmeh and is located in the northeast of Farmahin and the southwest of Tafresh. Based on the structural subdivisions of Iran, the mentioned area is a part of Central Iran and the Urumieh-Dokhtar magmatic belt (Hajian, 1970).

The studied volcanic rocks consist of trachybasalt, trachyandesite, basaltic andesite, andesite, dacite, rhyodacite, rhyolite, ignimbrite, tuff and tuffit in composition and in terms of age they belong to the middle and upper Eocene. It seems that the volcanic activities are related to folding and faulting in the studied area. On the other hand, in addition to causing orogenic activity, at the middle and upper Eocene (Ghasemi and Talbot, 2006), locally extensional regime has played a main role in volcanic eruption. Similar to this scenario happened in other areas such as Taft and Khizrabad in Central Iran (Zarei Sahamieh et al., 2008). Porphyritic, microlite porphyritic and microlitic are the main textures in these rocks. Mineralogically, they contain plagioclase, clinopyroxene, amphibole, quartz and biotite as the main minerals and zircon, apatite, and opaque minerals as accessories.

Materials and methods

The major and trace elements of mineral composition are determined by electron probe micro-analysis (EPMA) using a Cameca SX100 instrument in the Iran Mineral Processing Research Center (IMPRC). Moreover, the whole-rock major and some trace elements analyses for a few samples were obtained by X-ray fluorescence (XRF), using an ARL Advant-XP automated X-ray spectrometer.

Results

Based on EPMA analyses, plagioclase mineral in basaltic andesite and trachybasalt samples range from labradorite to bytownite in andesite and trachyandesite has oligoclase- andesine and in dacite, rhyodacite, rhyolite has an albite-oligoclase composition. In the Wo-En-Fs diagram, all clinopyroxenes show augitic and a lessor amount of clinoenstatite composition and in the Q-J diagram located in the Mg-Fe-Ca (Quad) field and in the 2Ti+Cr+Al^{VI} *vs.* Na+Al^{IV} diagram (Morimoto et al., 1988) located above on the Fe^{3+}=0 line that indicate high oxygen fugacity during crystallization. Microscopic study on these rocks such as oscillatory zoning, resorption rims in plagioclase and the presence of basic inclusions suggest the occurrence of magmatic contamination on the parent magma. The presence of oxidized amfibool rims (in hornbelende as oxy hornbelende) indicate the high temperature of the magma at the time of eruption.

According to the classification diagrams such as total alkaline *vs.* SiO_2 (Irvine and Baragar, 1971) TAS (Le Bas et al., 1986) and tectonic discrimination diagrams (Pearce et al., 1984) samples are plotted in sub-alkaline, basaltic-andesite, andesite, dacite and rhyodacite, subduction and volcanic arc fields, respectively.

The geochemical diagrams such as AFM are used

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for the identification of magma series and show that the studied rocks are calc-alkaline and A/NK *vs*. The A/CNK diagram shows the metaluminous to peraluminous nature. Incompatible and LIL elements such as Ba, K and Rb enrichment show that the contamination of magma with continental crust has occurred. The similarity between the REE patterns in all of the collected samples in Alam Baghi, Vashaghan, Sarban and Ghermez Cheshmeh areas suggest the same source for all of the volcanic rocks.

Discussion

The tectonic setting diagrams show that these rocks belong to the continental margin which has been involved in a subduction zone.

The position of the samples on the major elements *vs.* SiO_2 diagrams indicate that magma differentiation has occurred. Spider diagrams show a positive anomalous in Rb and a negative anomalous in Nb and Ti This phenomenon shows a contamination between the magma and the crustal rocks (Rollinson, 1993). Also, MORB-normalized incompatible element patterns of the Farmahin area show that the parent magma has been contaminated. It appears that assimilation and fractional crystallization (AFC) were the dominant processes in the genesis of the studied volcanic rocks.

As a conclusion and according to field evidence and geochemical characteristics presented in this article, the studied area is composed of lava flows and pyroclastic rocks such as andesite, dacite, rhyodacite, ignimbrite, tuff and tuffits that cross cut by younger dykes and belong to the middle to late Eocene age (middle to upper Lutetien). According to Sm/Yb *vs.* Sm diagram (Aldanmaz et al., 2000), all the studied samples in terms of composition are similar to enriched mantle-derived melts that are generated by varying degrees of partial melting (10% - 20%) from a spinel lherzolite to spinel-garnet lherzolite source.

Considering the evidences, all rocks in the studied area belong to the subduction zone and the parent magma originated from mantle and was contaminated with continental crust during eruption and rising.

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