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Petrography, geochemistry and tectonic setting of Salmabad Tertiary volcanic rocks, southeast of Sarbisheh, eastern Iran

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Introduction

The area reviewed and studied in this paper is located 5 km southeast of Sarbisheh city at eastern border of the Lut block (Jung et al., 1983; Karimpour et al., 2011; Richards et al., 2012) in eastern Iran between 59° 47′ and 59° 53′ E longitude and 32°30′ and 32°34′ N latitude. The magmatic activity in the Lut block began in middle Jurassic (165-162 Ma) and reached its peak in Tertiary (Jung et al., 1983). Volcanic and subvolcanic rocks of Tertiary age cover over half of Lut block with up to 2000 m thickness and formed due to subduction prior to the collision of the Arabian and Asian plates (Camp and Griffis, 1982; Tirrul et al., 1983; Berberianet et al., 1982). Most of magmatic activity in the Lut block formed in middle Eocene (Karimpour et al., 2011) The andesitic volcanics were erupted together with the dacites and rhyodacites during a time interval of some 50 Ma from early Cretaceous to early Neogene. It can be assumed that the intensity of the volcanic activity was varying significantly during this time span (Jung et al., 1983).Tertiary volcanic rocks (Eocene-Oligocene to Pliocene) with intermediate composition associated with pyroclastic rocks cropped out in eastern parts of Salmabad village, southeast of Sarbisheh. The main purpose of this paper is better understand the tectono-magmatic setting of the Tertiary volcanic rocks in southeast of Sarbisheh, eastern Iran based on geochemical characteristics.

Materials and methods

Eleven samples were analyzed for major elements by inductively coupled plasma (ICP) technologies and trace elements were analyzed using inductively coupled plasma mass spectrometry (ICP-MS), following a lithium metaborate/tetraborate fusion and nitric acid total digestion, at the SGS Laboratories, Toronto, Canada.

Results

In the Salmabad area, Tertiary volcanic rocks with mainly intermediate (andesitic) composition are exposed associated with pyroclastic deposits such as tuff, breccia and agglomerate. Extrusive rocks include andesite (pyroxene andesite) and basaltic andesite. Zoning, sieve texture and embayment of plagioclase phenocrysts and existence of reaction rims around pyroxenes are evidences for disequilibrium conditions during magma crystallization. These rocks have medium to high-K calc-alkaline nature and show enrichment in LILE (except for Ba) and depletion of HFSE. The Salmabad area lavas have 102-155 ppm total REE and display coherent REE patterns characterized by enrichment in LREEs relative to HREEs ($(La/Yb)_{N=}$7.35-9.71; $(Ce/Yb)_N$=5.43-6.81)), nearly flat HREEs ($(Tb/Yb)_N$=1.05-1.40) and weak negative Eu anomalies (average Eu/Eu*=0.78). Geochemical characteristics of the Salmabad volcanic rocks such as enrichment in LREEs relative to HREEs in association with enrichment in LILE and negative anomalies of Nb, Ti and P show their relation to subduction zone. The range of $Mg^{\#}$ is 45.1-57.1 for the Salmabad andesites and 69.8 in basaltic andesite indicating the involvement of mantle components. The isotopic compositions ($(^{87}Sr/^{86}Sr)_i$=0.7045 and $\varepsilon_{Nd}(t)$=3.1 for the Salmabad andesites point to a mantle origin.

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Discussion

Orogenic magmas are defined geochemically as showing diagnostic Nb-Ta trough and enrichment in large ion lithophile elements (LILE) such as Th, Pb, Sr and K in primitive mantle normalized trace element variation diagrams (Kuscu and Geneli, 2010). The origin of this kind of geochemical signature is commonly interpreted as subduction-related setting (Gill, 2010), in sources that had undergone mantle wedge metasomatism (Seghedi et al., 2001) or crustal contamination of mantle-derived magmas (Harangi et al., 2007). The andesitic magma in Salmabad area displays an orogenic signature, i.e., enrichment in LILE and Th, and relative depletion in Nb, Ti and P. The dominance of positive εNd(t) values (3.1) for the studied rocks indicate a mantle origin. High values of Sr, Th and U in these rocks can be related to crustal contamination. Thus, the orogenic signature of these rocks is attributed to the mantle source, presumably metasomatized by the Sistan ocean subduction. The trace element features are consistent with the roles played by subducted sediments and fluid released from the subducted slab in magma genesis.

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