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Geochemistry, geochronology and petrography of feldspathoid-bearing rocks in the Urumiyeh-Dokhtar volcanic belt, Iran

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GEOCHEMISTRY, GEOCHRONOLOGY AND PETROGRAPHY OF FELDSPATHOID-BEARING ROCKS IN THE URUMIYEH-DOKHTAR VOLCANIC BELT, IRAN

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DEDICATI0N

I dedicate this thesis to my parents, my wife Masoumeh and my daughters Maryam and Negar.

Except where otherwise acknowledged, this thesis represents the author's original research, which has not previously been submitted to any institution in partial or complete fulfilment of another degree.

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ABSTRACT

The Urumiyeh-Dokhtar Volcanic Belt (U-DVB) is the largest volcanic belt in Central Iran and originated as a continental arc in the Tertiary. This dissertation summarises the results of a detailed petrographic, geochemical and isotopic study of potassic rocks from three areas of this belt, comprising the Islamic Peninsula, Aghda and Shahrbabak. The U-DVB is composed mainly of tephrite, tephriphonolite, phonotephrite, phonolite, basalt, trachybasalt, basaltic trachyandesite, trachyandesite, trachyte, dacite and rhyolite. The Islamic Peninsula stratovolcano was active between 8 and 6.5 Ma and produced magmas with between 43.5 and 58.0% SiO_2. All rock types have common mineralogical and textural characteristics. The Aghda region is composed of volcanic rocks which range in age from 23.5 to 15.7 Ma and contain between 49.8 and 71.2% SiO_2. Tephriphonolite being characterised by the occurrence of abundant (commonly 40% by volume), large trapezohedra composed of single crystals of analcime or aggregates of pumpellyite. Volcanic rocks from Shahrbabak have isotopic ages between 37.5 and 2.8 Ma and SiO_2 contents from 47.2 to 67.6%.

Diopside is the only pyroxene present in samples from all three study areas and usually shows decreasing contents of MgO from core to rim, reflecting normal magmatic evolution. Sanidine is the only K-feldspar present in all samples. Plagioclase phenocrysts usually show Ca-rich cores and Na-rich rims, reflecting normal magmatic evolution. Titanomagnetite is the most common Fe-Ti oxide in rocks from the study areas and olivine has a compositional range from $Fo_{85.1}$ to $Fo_{85.6}$. Leucite occurs in rocks from the Islamic Peninsula but this phase has undergone ion-exchange pseudomorphous replacement by analcime in the other two areas. In the Aghda area analcime in the lowest tephriphonolite became unstable and was replaced by pumpellyite which has a wide compositional range, reflecting variable input of Fe, Mg, Ca and Al from the precursor analcime and alteration of inclusions.

Lavas from the Islamic Peninsula are undersaturated in SiO_2 and have high contents of CaO, K_2O and other incompatible elements, and low contents of Al_2O_3, TiO_2, and compatible elements. Rocks from Aghda are characterised by being oversaturated to undersaturated in SiO_2, high in Al_2O_3, CaO and alkalies and incompatible elements but low in TiO_2, MgO and compatible elements. The rocks from Shahrbabak are characterised by being saturated to undersaturated in SiO_2, with low Mg-numbers and contents of TiO_2 and compatible elements, but high contents of Al_2O_3, CaO and the incompatible elements.

The U-DVB developed in the Tertiary in response to northeastward subduction of the Neo-Tethys lithosphere beneath the Central Iran Plate. This tectonic setting together with geochemical and isotopic data provide strong evidence of the involvement of subduction-related processes in the generation of potassic magmas in the U-DVB. The ε_{Nd} values (+1.3 to +4.1) and initial $^{87}Sr/^{86}Sr$ ratios (0.70427-0.70567) for samples from Shahrbabak volcanic rocks are markedly different from those of the Islamic Peninsula and Aghda (ε_{Nd} = -2.2 to -4.7; initial $^{87}Sr/^{86}Sr$ = 0.70651-0.70871) and probably reflect differences in the mantle sources. Geochemical variations in Shahrbabak rocks, particularly in initial $^{87}Sr/^{86}Sr$ ratios and contents of Ba (280-1450 ppm), LREE and incompatible elements reflect heterogeneity in the mantle source. The source mantle for the Islamic Peninsula magmas was heterogeneously enriched in LFSE and LREE, probably during metasomatism by fluids released from the subducted slab. The mafic-intermediate rocks from Aghda with high K, LREE, Th, Zr, $^{87}Sr/^{86}Sr$ and low ε_{Nd} were generated by partial melting of mantle previously metasomatised by fluids derived from dehydration of the subducting oceanic crust and overlying sediment, but felsic rocks with high initial Sr isotopic ratios (0.70871) and low Sr contents were probably derived by anatexis of continental crust.

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