©2022 International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

ISSN 2228-9860 eISSN 1906-9642 CODEN: ITJEA8

TuEngr Group

International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies

http://TuEngr.com

Mineral Geochemical Studies & Determination of Tectonomagmatic Environment of Triassic Basalt Rocks in Sartangeh Region in North Semnaan of Iran

Mehdi Zamani[1], Seyed Jamal Sheikh Zakariaei[1*], Mohammad Reza Ansari[1]

[1] Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, IRAN.
**Corresponding Author (Email: Sheikhzakariaee@srbiau.ac.ir).*

Paper ID: 13A2D

Volume 13 Issue 2

Received 23 July 2021
Received in revised form 19 October 2022
Accepted 26 October 2022
Available online 01 November 2022

Keywords:
Basalt, Mineral Geochemistry, Tectonomagmatic Environment, Semnan, Central Alborz, Iran.

Abstract

The study area is Sartangeh Shahmizad, located in the north of Semnan and is part of Central Alborz in terms of construction geology. This area is anticline along the axis of west-northwest, east-southeast and the studied volcano is from the upper Triassic-Jurassic rock units with a definite boundary, and above is covered with a normal boundary by a sequence of sandstone, shale Shemshak formation. In line with the petrographic study, volcanic rocks in the study area are mainly basaltic igneous. Basalts with porphyric texture with microlytic paste to glass. Based on the chemistry of pyroxene mineral, basalt is in the range of alkaline to tholite rocks. Most basalt samples in the tectonic environment determination diagrams are based on the chemical composition of pyroxene and located in the range of the intercontinental rift environment and calc-alkaline magmas. With the help of the chemical composition of pyroxene, the temperature for the rocks of the region is estimated 500-1000 degrees Celsius at atmospheric pressure one. Moreover, with the help of the chemical composition of plagioclage, the basalt formation temperature of the region is estimated 650-750 degrees Celsius. In terms of mineral chemistry studies and the tectonic-magmatic environment diagrams, these rocks are within the in-sheet basalts range. Consistent with these findings, it can be concluded that the role of water-saturated asthenosphere ascent with amphibole garnet lerzolite has been significant for the formation of primary magma of volcanic basaltic rocks in the Sartangeh region. During this process, the impact of asthenosphere ascent and local tensions affected by impact zones is a factor to reduce pressure and a passage for Makma to reach the surface and the asthenosphere in the presence of high water has different melting degrees is part of an amphibious peridotite garnet source.

Disciplinary: Geology.

Cite This Article:

Zamani, M., Zakariaei , S. J. S., Ansari, M. R. (2022). Mineral Geochemical Studies & Determination Of Tectonomagmatic Environment of Triassic Basalt Rocks in Sartangeh Region in North Semnaan of Iran. *International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, 13*(2), 13A2D, 1-11. http://TUENGR.COM/V13/13A2D.pdf DOI: 10.14456/ITJEMAST.2022.25

1 Introduction

The study area is located in Sartemgeh Shahmizad of Semnan, between geographical coordinates of 40°, 35° -00, 36° north latitude and 20°, 53° -00, 53° east longitude (Figure 1). This area is in the central part of Iran's primary northern mountain range (Alborz mountain range) in terms of its geological location. The study area was first investigated by (Jenny, 1977) and (Stampeli, 1978). Cretaceous and earlier volcanic rocks were studied by (Jenny, 1977) in this area. Due to severe alteration and the effect of various processes after magmatic dimensions, these volcanic rocks were not studied by later researchers. Even though this volcanic complex with its Middle-Upper Cretaceous formations is notable in Iranian geology, but to date, no exact geochemical work has been performed on it. In this study, Triassic era basalt rocks were assessed via petrological and mineral geochemical analysis.

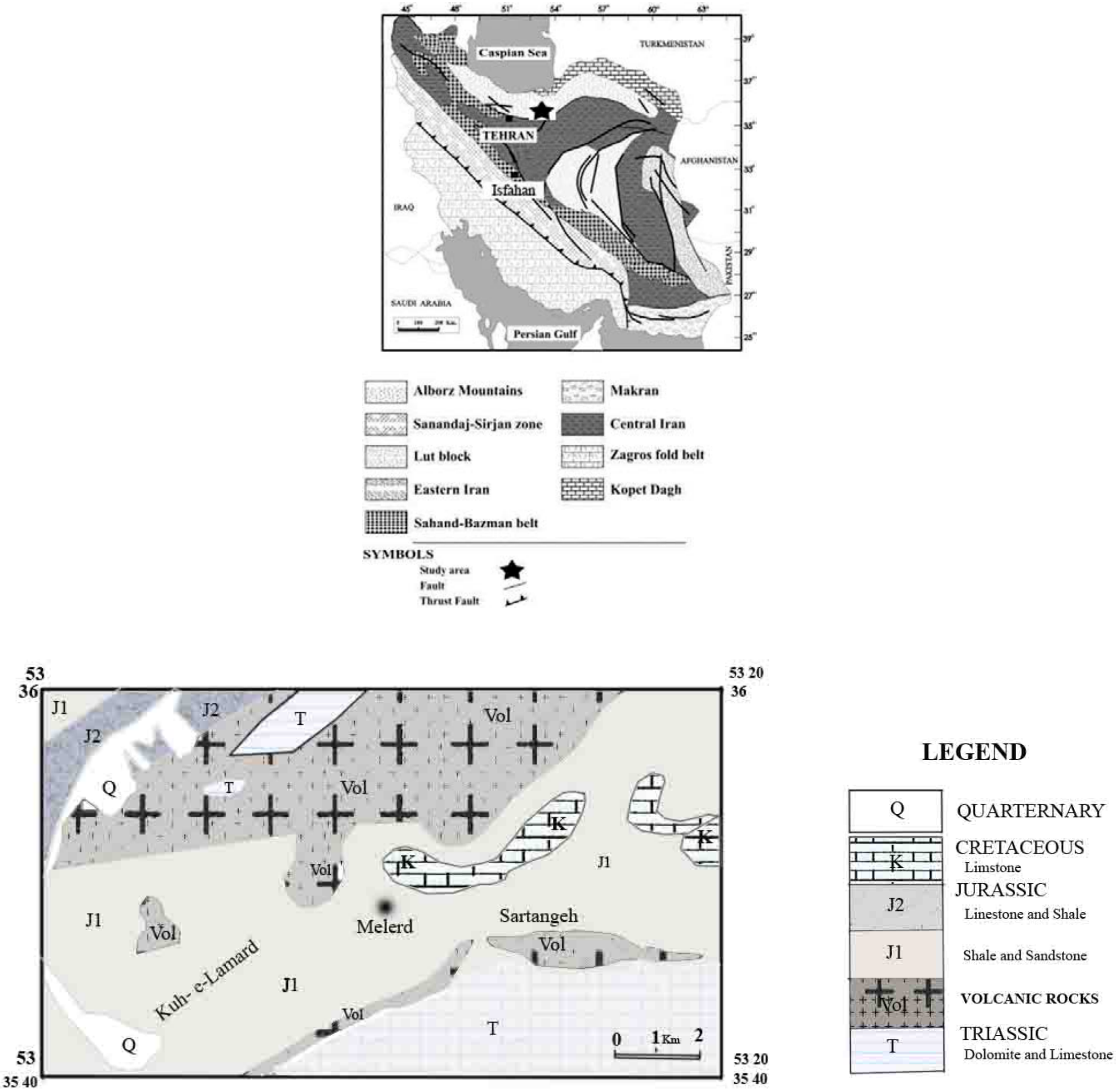


Figure 1: Geological Map of Study Area (Quoted By Nabavi 1998 With Changes).

2 Region’s Geology

In terms of structural geology, the study area is an anticline with an axis west-northwest, east-southeast, with an axial inclination to the east and southeast (Figure 1). The studied volcano is on the upper Jurassic-Triassic rock period with a definite boundary, and above it, is covered with a normal boundary by a sequence of sandstone, Shemshak formation shale (Figure 1). One of the interesting structures in the volcanic assemblage is the Columnar Joints, connected to the feeder dikes (with structures similar to basaltic prisms).

3 Research Methodology

During field visits, 74 rock samples were collected from various sections of volcanic outcrops. Pursuant to detailed petrographic analysis, in order to study microprop and mineral chemistry on the basalts of the study area, a sample of a thin section with appropriate cross-sections was selected from the logic outcrops and analyzed by electron probe microanalysis (EPMA).

4 Findings

4.1 Lithography

The basalts are porphyric in texture with a microlytic to glassy paste. Plagioclase in this group of rocks is formed to shape with albite-carlsbad model and rarely with zoning texture. Olivines are from shaped or amorphous and in most cases severely altered. It is not possible to identify these minerals due to the intensity of alteration and they can only be identified by the shape of the mineral.

Pyroxene is dispersed from shaped to amorphous with a frequency of approximately 15% in the rock text. Based on optical properties, these pyroxenes are of the Augit type. The paste is composed of very fine plagioclase microlytes, microcrystalline pyroxenes, opaque minerals, altered olivines and glass. Due to gas and volatile emissions, in the paste, voids are filled by secondary minerals such as calcite, microcrystalline chlorites and OPAC minerals.

4.2 Mineral Geochemistry

Due to their mineralogical importance (Zadeh et al., 2022), in this research, three minerals, specifically pyroxene, plagioclage and olivine, were evaluated.

The diagram provided by Morimoto & Associates (1988) was utilized to determine the clinopyroxene type. In the diagram, pyroxene has a compound spectrum in the diopside-augite range (Figures A & B2). The study by Duda & Schmincke (1978) indicates that the presence of $Al2O3>5.4$ & TiO2 approx. 2% by weight is common in alkaline rocks. According to the Magmatic Series Determination Chart (Le Bas, 1962), the clinopyroxene mineral samples are in the range of alkaline to tholite rocks, and it appears that most of the minerals in the tholite range are titanium-free or low-titanium diopside minerals. (Figure C2).

In the diagram of changes of Allv+Na versus Alvl+2Ti + Cr to estimate oxygen fugacity (Schweitzer & Associates, 1979), the major mineral samples of clinopyroxene are within and above the =0Fe+3 line (Figure D2).

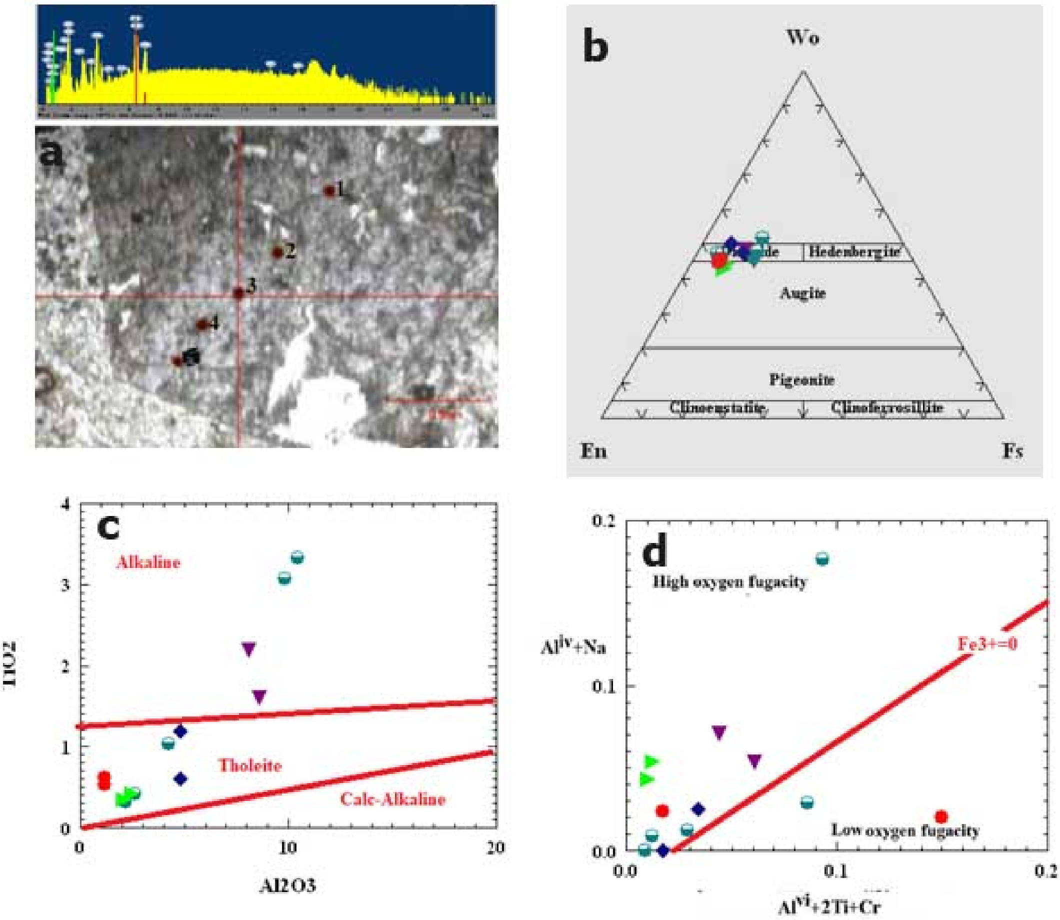


Figure 2: Microanalysis Studies Of Electron Probes On Pyroxene. A) Electron Propane Microanalysis (EPMA) Image Of Pyroxene, The Points Analyzed On The Electron Microscope Images Are Marked As Numbers & Spectral Analysis Is Among The Analyzed Points (Can Be Observed In The Attached Tables). B) Classification Of Pyroxenes In The region On The (Morimoto & Associates, 1988) Diagram, C) Use Of Clinopyroxene Mineral To Determine The Magmatic Series (Le Bas, 1962), FD) AlIV+Na Diagram Versus AlIV+2Ti+Cr For Estimation Of Oxygen Fugacity (Schweitzer, 1979).

From the tectonic environment diagram (Le Bas, 1962), most of the specimens are within the intercontinental rift environment and the intercontinental tholites (Figure 3A). In the (Hout & Associates, 2002) tectonic diagram, most of the samples are in the subcontinental rift environment and some are in the range of calc-alkaline magmas (Figure 3B). In the AlVI/AlIV diagram, the placement of the samples is observed in the high to medium pressure range (Figure 3C). In clinopyroxenes containing aluminum at high pressure with the NaALSi3O8-NaALSi2O6+SiO2 action and at low pressure with the CaAl2Si2O2+ CALl2Sio6+SiO2 reaction (Green & Ringwood, 1967), the first reaction is at a depth of about 120 km (containing garnet peridotite) & the second reaction occurs at a depth of less than 40 km. To determine the depth of the magmatic reservoir, the aluminum existing in the structure of pyroxenes was used. Researchers including (Helz, 1983) have emphasized that the distribution of aluminum in the quadrilateral and octahedral positions of clinopyroxenes is a suitable criterion for estimating the water magma levels as well as the prevailing pressure on the igneous rock formation environment. With this model, the bulk pressure of the samples is 5 kb of the crystallized pyroxenes and the magma water is between 5 & 10% (Figure 3D). AlVI values decrease in response to an increase in temperature in the pyroxene crystallization medium (Heltz, 1973).

The OW-Eb-Fs ternary system was deployed to thermometrically measure the rocks of the region utilizing the chemical composition of pyroxene. The temperature estimation for the rocks of the region is about 500-1000°C (at atmospheric pressure one) (Figure 4).

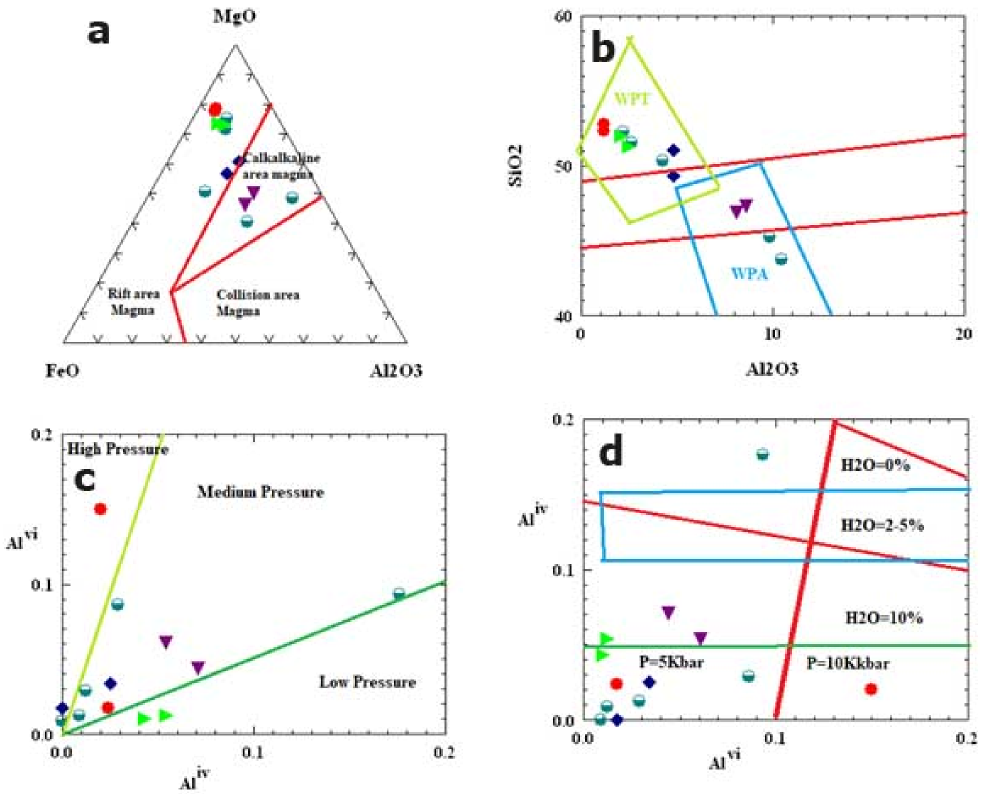


Figure 3: Determination Of Magma Formation Conditions With The Aid Of Pyroxene Chemistry, A) Utilization Of Clinopyroxene Mineral To Determine The Tectonic Environment (Le Bas, 1962) & (Hout & Associates, 2002), B) Use Of Clinopyroxene Mineral To Determine The Tectonic Environment of AB Alkaline Basalt, WPA Intermediate Alkaline, WPT Basalt Tholite Interstitial Basalt: Oceanic Basalt, (Le Bas, 1962), C) Barometer Diagram Of AlVI vs. AlVI (Aoki & Shiba, 1993); (Helz,1973).

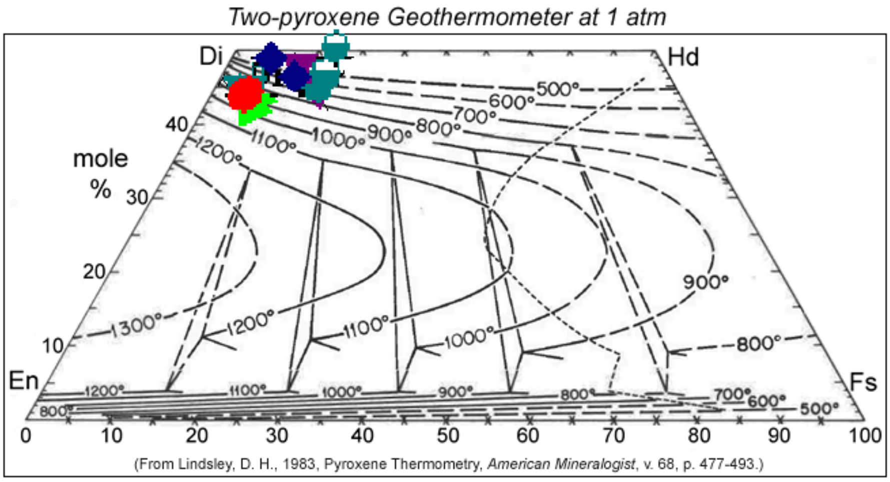


Figure 4: Wo-En-Fs Diagram Of Clinoproxen For Temperature Estimation; From (Lindsley, 1983)

Utilizing the findings of micro-analysis of electron prop, the type of plagioclase was determined via various diagrams (Figure 5A). On the Or-Ab-An triangular diagram from (Deer & Associates, 1999), plagioclase igneous rocks of the region are within the range of bitonite to labradorite (Figure 5B). In order to thermometrically measure the rocks of the region with the help of plagioclase chemical composition, the Or-Ab-An ternary system was utilized. Temperatures or various rocks are estimated between 650-750°C f (Figure 5C).

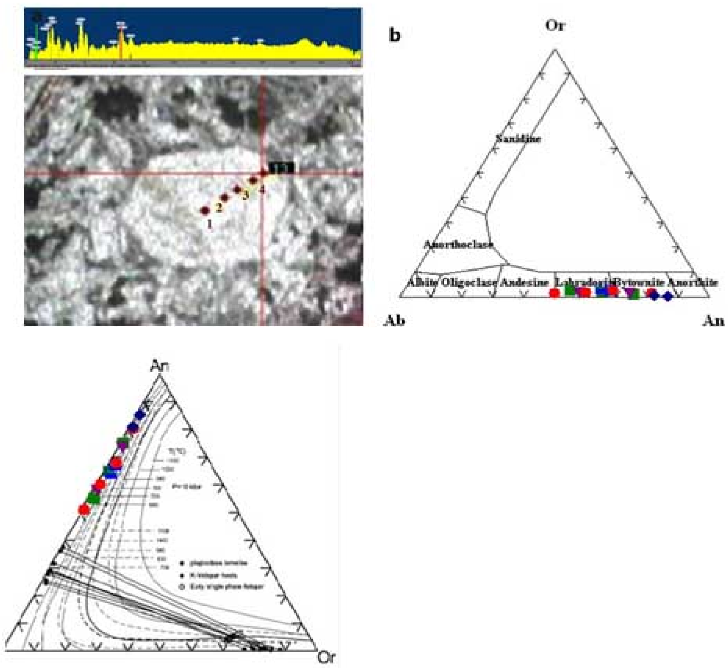
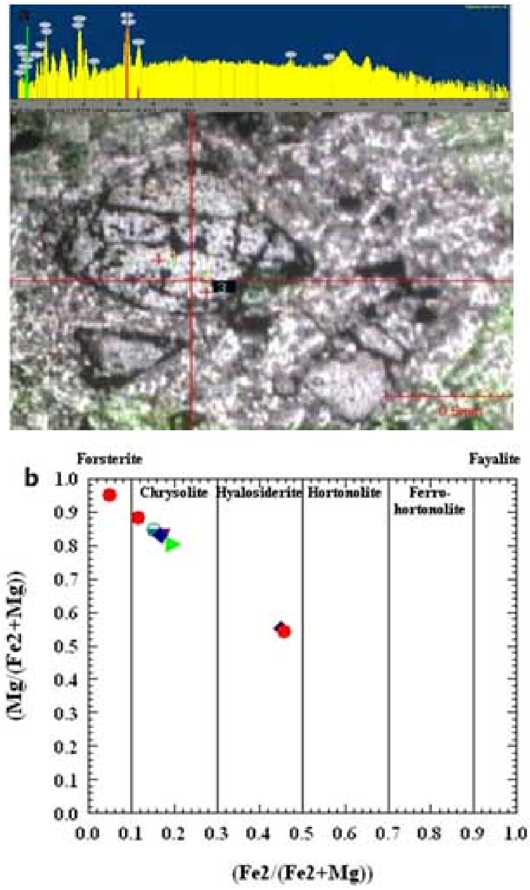


Figure 5: A) Image Of Electron Prop Analysis (EPMA) Of Plagioclase Points Analyzed On Electron Microscope Images, B) Determination Of Plagioclase Type. C) For Temperature Estimation (From Or-Ab-An Seck, 1971)

The olivine classification diagram was utilized to determine the type of olivine and the mineral chemistry of olivines (6). Figure 6A displays the location of the point analysis of olivines in one of the rocks in the area via the electron prop analysis (EPMA).

According to the Wager & Deer (1939) diagram, the olivines of the sample in question are primarily within hyalosiderite as well as a few hortonolites (Figure 6B).



1

Figure 6: A) Image Of Electron Prop Analysis (EPMA) Of The Region's Olivines, B) Segmentation Of The Olivines Grounded On Chemical Composition

4.3 Tectonomagmatic Environment

The Meshede (1989) study's diagram was utilized to determine the tectonomagmatic environment of the Sartangeh region. In these diagrams, where incompatible and non-moving elements Ti, Y, Th, Nb, Ta & Zr were utilized to divide various fields, all samples taken from Sartangeh were within the WPB basalts and mainly demonstrate a crustal contamination process as well as mantle metasomatism with varying degrees of melting. In the Ta/Yb-Th/Yb diagram (Figure 7), the proportions of these elements are highly sensitive to mantle composition, pressure changes, and varying degrees of melting, therefore, it confirms the source/sources of oceanic island basalts (OIB), enrichment in the asthenosphere mantle and different levls of melting in the formation of primary magma of volcanic rocks in the Sartangeh region. Magmatic tectonics are within the intraplate basalts area, but the crustal contamination of these magmas tends to tectonic environment of these rocks to volcanic arc basalts, and due to the location of the central Alborz tectonics environment, such conditions for the region is out of the realm of possibility. Considering that the old volcanism of the Sartangeh area and the role of post-magmatic processes can be effective in changing its chemical composition, in the above diagrams that use non-moving elements, the initial and magmatic properties of these rocks are quite evident. Figure 8 displays the Nb/Th-Ce diagrams of all the major examples of Sartangeh in the OIB range, and the role of the upper, middle, lower, and subcontinental crusts in primary magma pollution is estimated to be negligible, and on the other hand, the mantle lithosphere can also reveal the properties of an OIB source magma, hence (Li & Associates, 2002), toward identifying and separating subcontinental mantle lithosphere, crustal contamination and determination of asthenospheric magma presented the Nb/Th-Ti/Yb diagram (Figure 8) and utilized the mentioned ratios (the main position of the samples is located in the OIB resources). The Ce/ Pb-Nb/U diagram demonstrates that the major specimens are within, outside and close to the OIB range and indicate the weak role of the crust in the contamination of the magma that forms the volcanic rocks of the Sartangeh region (Krinitz & Associates, 2007). In the Ce/Pb versus K/La diagram, the majority of the samples are located within the Red Sea and early mantle basalts (Figure 8) and a small number of samples display slight contamination with the Precambrian crust. Contaminated materials with a low Ce/Pb ratio point to the role of old crusts in the evolution or regeneration of magma, and demonstrate that between 20-30% of old crusts participate in the evolution or regeneration of magma.

Hence, in order to determine the process as well as the developments of primary magma production of volcanic rocks in Sartangeh region due to the degree and type of melting of magmatic source sources and in line with the study of (Shaw & Associates, 2003), it appears the main lava produced is the parent rock of volcanic eruptions in the Sartangeh area and belongs to the melting of a peridotite garnet mantle with various levels of melting and excludes the production of a mixture of peridotite garnet with peridotite spinel melt (Krientz & Associates, 2007), (Figure 9).

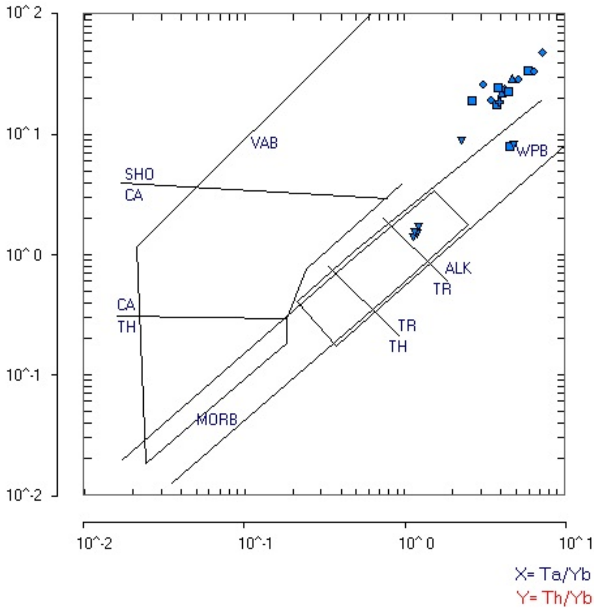


Figure 7: Determination Of Tectonic Nomagmatic Environment Of Volcanic Rocks Belonging to the Sartangeh Region, Utilizing The (Meshede, 1989) Diagram.

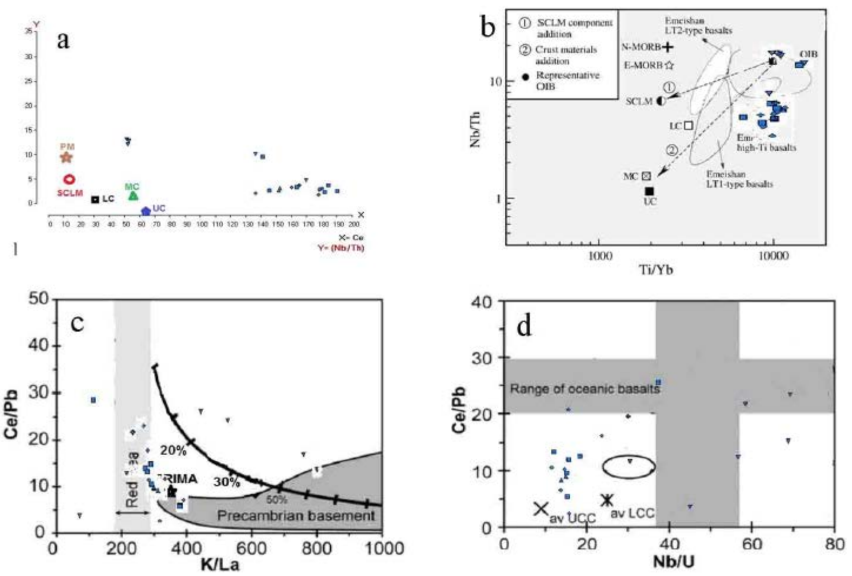


Figure 8: Ratio Of LILE, HFSE & REE Elements Analysis Toward identifying The Behavior & Sources Of Magma Production Of Volcanic Rocks in Sartangeh Region.

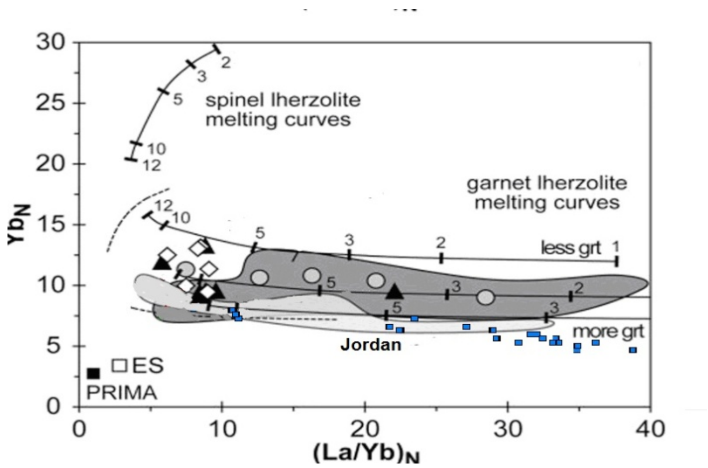


Figure 9: La/Yb-Yb Changes Normalized To Chondrite (Macdonough & Sun, 1995) Diagram For Determining The Source & Melting Degrees Of Cretaceous Volcanic Rocks In Sartangeh Compared To The Arabian Crust

5 Conclusion

Compliant with the mineral chemistry analysis, the basalts of the Sartangeh region demonstrate that these rocks are associated with the magmatism of the intercontinental rift zones and that from the Triassic onwards and in the area where the volcanism of the Sartangeh region is exposed, the asthenosphere has been elevated. Asthenospheric ascent and local fractures due to rift phases have caused the production of magma in the depths, volcanism of volcanic rocks in the head of the gorge linearly along with these fractures. The volcanism of the volcanic rocks of the Strait region has no connection with the divergent or convergent boundaries of the lithosphere sheets.

In a general perspective, it can be concluded that the Alborz mountain range is the "forehead" of Central Iran and a member of the Arabian plate, and that in the Hersinian era, the two continents of Europe and Asia had a convergent movement towards each other, and in the Late Triassic, simultaneous with the occurrence of the Early Cimmerian, this collision was completed in totality and in the younger orogenic phases, this orogenic process continues Agha-Nabaati, 2005, hence this region is known as a collision zone.

The preliminary magmas obtained from these heterogeneous garnet-bearing sources reveal melting degrees between 1-5% of the melting point of lherzolite-rich garnet sources, hence these changes in melting degrees are a function of modifications in depth and enrichment of incompatible elements in various mantle sources. In a general conclusion, we can point to the role of ascent of water-saturated asthenosphere with amphibole garnet lerzolite in the formation of primary magma of volcanic rocks of basalts in the Sartangeh region, and due to the ascent of the asthenosphere and local tensions, the impact zones are a factor to reduce pressure and a passage for magma to reach the surface, and the asthenosphere with a high level of water present, undergoes various melting degrees as part of an amphibious peridotite garnet source.

6 Availability of Data and Material

Data can be made available by contacting the corresponding author.

7 References

Agha-Nabaati, A., 2005. Geology of Iran. Iran Geological Survey Publications, 586 pages.

Jenny, J., Stampfli, G., 1978. Lithostratigraphie du Permien de l'Elbourz oriental en Iran. Eclogae geologicae Helveticae 71, 551e580.

Krienitz, M, S, Hasse, K,M, Mezger, K, Shaikh-Mashail, M, A., 2007. Magma genesis and mantle dynamic at the Harrat Ash Shaam volcanic field (South Syria). *JOURNAL OF PETROLOGY* 48, 1513-1542.

Le Bas MJ, Le Maitre RW, Streckeisen A, Zanettin BA (1986) Chemical classification of volcanic rocks based on the total alkali-silica diagram. J Petrol 27:745–750

Macdonald, G.A. & Katsura, T., Chemical composition of Hawaiian lavas. J.Petrol.5,82-133(1964).

Marsh, R.B.W. & Miles, P.R., Models of the development of the west Iberia rifted continental margin at 40 30' N deduced from surfsce and deep-tow magnetic anomalies. J.Petrol.Res.100,3789-3806(1995).

Meschede, M., A method of discrimination between different types of mid-ocean-ridge basalt and continental tholeiites with the Nb-Zr-Y diagram. Chemical Geology .56,207-218(1986).

Nabavi, J. 1998. Geological Map of Baladeh (Scale: 1:100000). Geological & Mineral Exploration Organization of Ira

Stampfli, G.M., Etde geologique generale de l'Elbourz oriental au sud de Gonbad-e-Qabus, Iran NE, These

Sun, S.S. & McDonough, W.f., "Magmatism in the oceanic basalts" A.D. Saunders & M.J.Norry,Her ausgeber] ,Geol.Soc.Special Publ.42,313-345(1989).

Thompson, R.N., Magmatism of the british Tertiary Vilcanic Province. *Scott Journal of Geology*. 18,49-107(1982).

Mehdi Zamani is a PhD student in Geology from Science and Research Branch, Islamic Azad University, Tehran, Iran.

Dr.Seyed Jamal Sheikh Zakariaei is an Assistant Professor in the Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran. He is Vice Chancellor of the Faculty of Petroleum and Chemical Engineering in Iran.

Dr.Mohammad Reza Ansari is an Assistant Professor in the Department of Geology, Science and Research Branch, Islamic Azad University, Tehran, Iran