Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 1, p. 743-750, 2015
http://www.innspub.net

INNSPUB
RESEARCH PAPER

OPEN ACCESS

Petrology and geochemistry of tavshana volcanics located in the square (1: 100,000) of Astara, Iran

Mostafa Baratiyan, Ebrahim Nazemi*, Saeed Naeimi, Fatemeh Ghotb Tahriri

Department of Geology, The Science College, Islamic Azad University, North Tehran Branch, Tehran, Iran

Article published on January 01, 2015

Key words: Volcanic rocks, Tavshana, Eocene, Alkaline potassium, Continental tholeiitic, Megaporphyric.

Abstract

Tavshana volcanic rocks have a considerable outcrop to Eocene in the mountains of Talesh, West of Gilan Province in Iran. From petrographic point of view, they have the major composition of Trachyandesite with Mega porphyric tissue. Geochemically speaking, these rocks belong to Alkaline Potassium series and negative anomalies of Ti, Ta, Nb and positive anomalies of K and Pb are proof of contamination of these rocks with their continental crust. In diagrams identifying tectonic positions, Tavshana Trachyandesites are located within the rift basalts range in the continental plates. Studying the patterns of incompatible elements and comparing them with the values of continental Tholeiites indicates that primary magmas forming are similar to continental Tholeiites that have been contaminated by the rocks of upper continental crust. Eocene volcanism in this area is similar to that of inter-continental rifts so that our research shows that primary magma continental tholeiitic trachyandesite of the same region in which an inter-continental rift environment emanating from the upper continental crust rocks have been affected to some degree. We believe that the potassic feature is not of the characteristic of the origin zone but crustal contamination leads to rise in magma potassium and the formation of potassic series and false Shoshonites in the rocks of the region

***Corresponding Author:** Ebrahim Nazemi ✉ Nazemi.Ebrahim@yahoo.com

Introduction

Volcanism is the phenomenon of eruption of molten rock (magma) onto the surface of the Earth, where lava, pyroclastics and volcanic gases erupt through a break in the surface called a vent. It includes all phenomena resulting from and causing magma within the crust or mantle of the body to rise through the crust and form volcanic rocks on the surface.

The region of Tavshana, one of the countryside areas of Khotbesara is located around the northern city of Talesh and southwest of Astara west of Gilan Province (Fig.1). In this area copper mineralization have been observed which is located near Misseh Chuli region and the appellation of name of the region is due to the presence of copper rocks there. The area under study is located in sheets 1/100000 of Astara and is a part of Alborz-Azerbaijan tectonic zone. Structurally, it is comprised of the mounted area of Talesh, the recessed zone of Ardebil, and the recessed district of Caspian Sea where the mounted area of Misseh Chuli is a part of the mounted area of Talesh. Based on the 1/100000 map of Astara (Fig. 2), the main part of rocks of the area under study are consisted of volcanic rocks with more than 1000 thickness which are shown by the unit of E^p to Eocene.

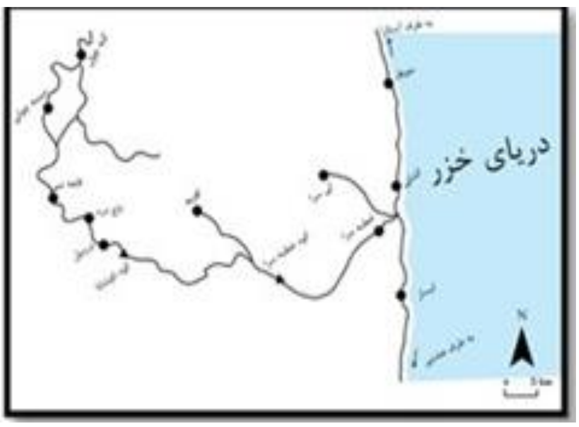

Fig. 1. Geographical location and access routes to the area under study.

The rocks of this area end in volcanic zone of Tarsir Mianeh-Ardebil from the west and from the south finish in Tarem zone. The aim of this article was study Petrology and Geochemistry of Tavshana Volcanics Located in the Square (1: 100,000) of Astara and characteristic of the origin zone in this area and indicates that primary magmas.

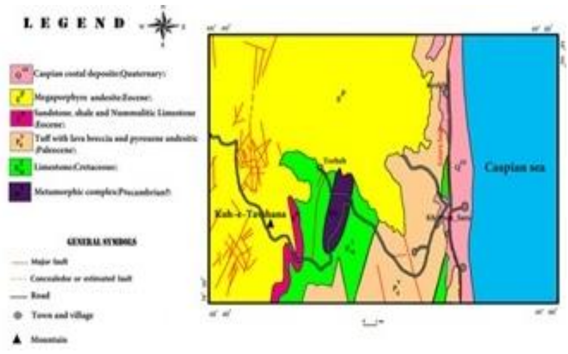

Fig. 2. Geological map of mountain range Tashvana based on 1/100000 map of Astara.

Material and methods

The study under area

The area under study is located in sheets 1/100000 of Astara and is a part of Alborz-Azerbaijan tectonic zone. Structurally, it is comprised of the mounted area of Talesh, the recessed zone of Ardebil, and the recessed district of Caspian Sea where the mounted area of Misseh Chuli is a part of the mounted area of Talesh. The main part of rocks of the area under study is consisted of volcanic rocks with more than 1000 thickness which are shown by the unit of E^p to Eocene. The rocks of this area end in volcanic zone of Tarsir Mianeh-Ardebil from the west and from the south finish in Tarem zone.

Results and discussions

Petrology

Microscopically the rocks in the area under study are comprised of plagioclase megacrysts which are placed in a gray area of fine crystals and have formed the megaporphyre tissues (Fig. 3). Plagioclase crystals in them reach 3 centimeters in size, too. Based on petrography studies, samples generally do not have diversity and are essentially formed of plagioclase crystals (80% of volume), pyroxene (5%) and secondary minerals such as apatites and opaka minerals. The dominant phenocryst has been plagioclase which is mainly in the form of polysynthetic (Fig. 4a). Some of the plagioclases also have a regional structure. Olivines are also placed after plagioclases based on their frequency in the form of phenocrysts. These minerals are completely altered and are sometimes altered to iddingsites and sometimes to bogites. Sometimes olivine crystals in form of poiklitics inside plagioclase megacrysts have been observed which shows the priority of olivine crystallizations in relation to the formation of plagioclase megacrysts (Fig. 4b). There is clinopyroxene in a small quantity and in the form of microphenocryst. As a secondary mineral apatites are also seen in small quantities and in the form of microphenocrysts (Fig. 4c). Magma of these rocks is made of plagioclase microlites whose pores are filled with alkaline philipsite and also clinopryxene.

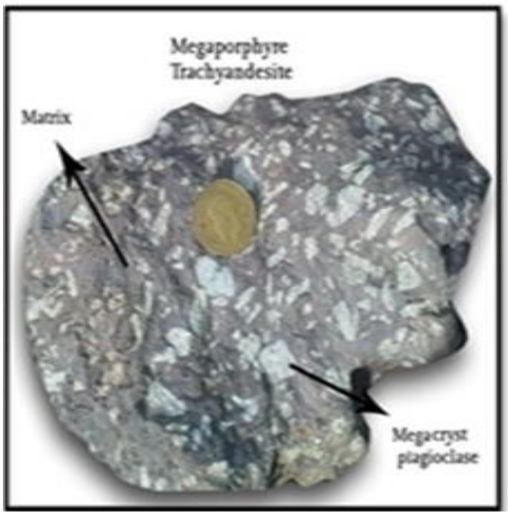

Fig. 3. A view of Tranchyandesite with Megaporphyre tissue.

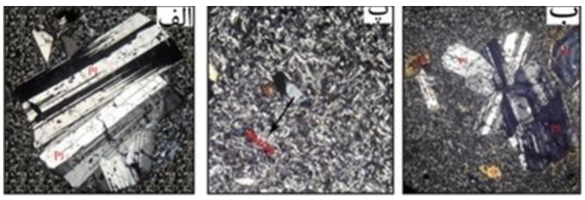

Fig. 4. A. Plagioclase Magacrysts, B. Present of olivine crystal beside Plagioclase Megacrysts, C. Present of Apatite mineral in Tranchyandesite.

Geochemistry

In the diagram, the total levels of silica against alkaline of all samples (Cox *et al.*, 1975) are located within the range of Trachyandesite and also within the range of alkaline series (Fig. 5). In Fig. (6) in the chart SiO_2 is placed beside Zr/TiO_2 of sample of (Winchester and Floyd, 1977) which is located in Trachyandesite range.

The relation of K_2O/Na_2O in the trachandesites of the region was on average 1.72, thus these rocks based on the categorization (Jaques *et al.*, 1985) belong to alkaline potassium series. Na_2O+K_2O in the rocks of the region were 8 on average and TiO_2 was around 0.75 which division (Muller *et al.*, 1992) shows the Shoshonite signs geochemically. But in calculating the norm, Hypersthene has been calculated so that in normative categorization (Irvine and Baragar, 1971) they are among rock of sub-alkaline series (Fig. 7). Also all the samples are of Nb/Y relation of less than 1 which based on the categorization (Winchester and Floyd, 1977) belong to rocks of sub-alkaline series.

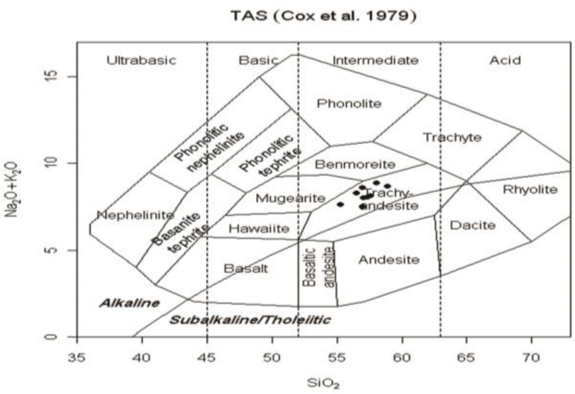

Fig. 5. The position of samples in SiO_2 alkaline chart next to silica of (**Cox** *et al.*, 1975).

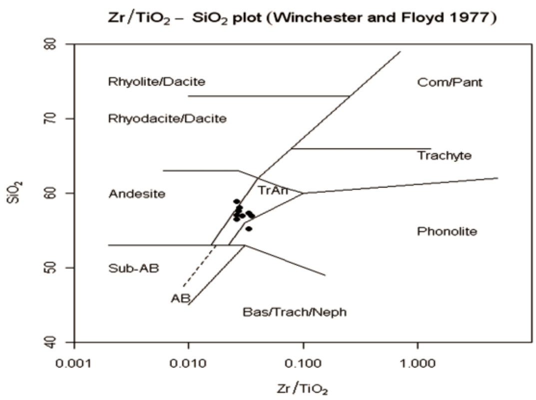

Fig. 6. The position of samples in Next to Zr/TiO_2 of (Winchester, and P. A. Floyd, 1977).

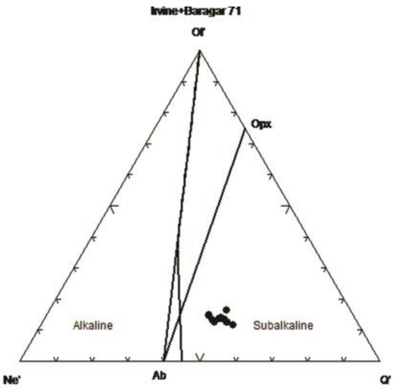

Fig. 7. The position of samples in normative chart of Ne-Ol-Q of. (Irvine and Baragar, 1971).

In FeO*/MgO diagram, along with SiO_2 of (Miyashiro, 1974) are located within all the tholeiitic series range (Fig. 8). In the following discussion, we examine the reason for this confusion in the magmatic series charts. In Figs. (9, 10) (Wilson, 1982), MgO and Al_2O_3 changes are shown beside SiO_2. SiO_2 variations in the rocks are low and in almost fixed quantities of SiO_2 values of MgO and Al_2O_3 vary vertically. This is a modal function of frequency of plagioclase and olivine.

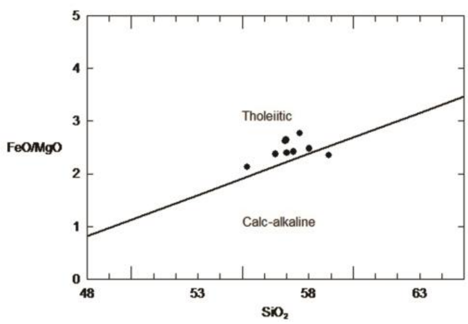

Fig. 8. The position of samples in FeO*/MgO Chart next to silica of (Miyashiro, 1974).

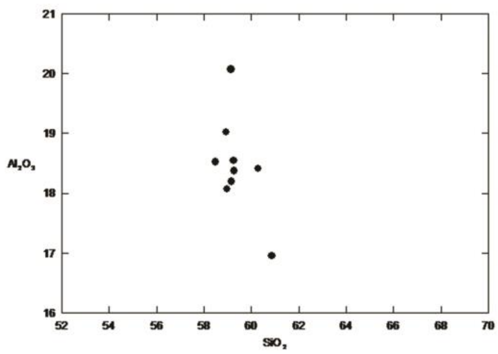

Fig. 9. Al_2O_3 changes compared to SiO_2 chart.

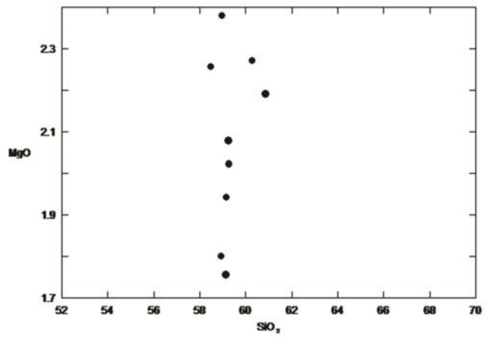

Fig. 10. MgO changes compared to SiO_2 chart.

In Fig. (11), patterns of regional trachyandesites are shown by primary mean normalized values (Sun and McDonough, 1989). Negative anomalies of Nb Ta, Ce, La, Sr, and Ta and positive anomalies of P, K, U, Pb are obviously observed in the samples. Positive anomaly of P is due to presence of apatite and apatite fractionates on the rocks. Negative anomaly of Sr along with Eu is indicative of plagioclase fractionates in shallow levels (Wilson, 1989; Rollinson, 1993). Although the negative Nb-Ta anomalies are of the prominent characteristics of their frequent areas (Wilson, 1989; Pearce, 1982), but inter-continental flooding basalts and rift basalts such anomalies have also been observed which has been attributed to crustal contamination (Wilson, 1989; Cox and Haw-kesworth, 1985). In general enrichment of elements LIL, positive anomalies of K, Pb and negative anomalies of Nb, Ti, Ta and also Ce, La are indicative of crustal contamination of magmas (Wilson, 1989; Fodor, 1983; Taylor, and McLennan, 1985 and Hofmann, 1997).

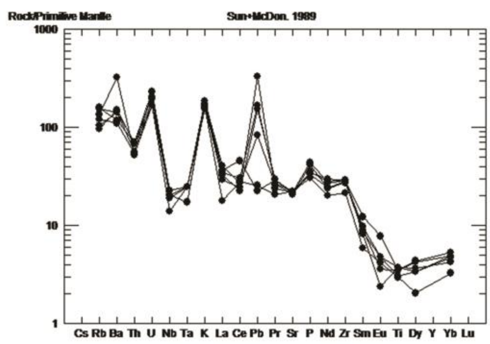

Fig. 11. Pattern of incompatible scarce trachyandesite elements normalized to primary mantle.

In Figs. (12, 13) the average pattern of trachyandesites of Misseh Chuli with average values of continental crust and also the upper continental crust (Rudnick and Fountain, 1995) have been compared. Identical ups and downs and similar elemental trends show very well the interaction between rock generating magma of the region and the continental crust. Crustal contamination phenomenon is well clear from the relation of scarce rocks of the region.

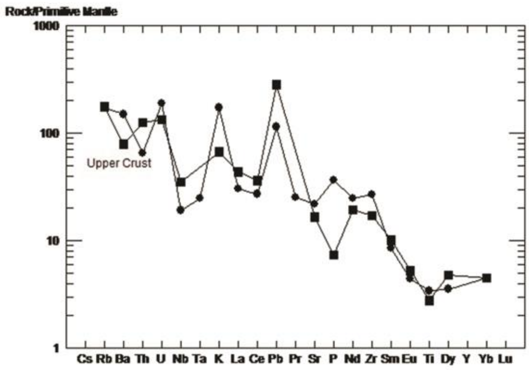

Fig. 12. Comparison of the average pattern of trachyandesites of the region in comparison with mean values of continental crusts.

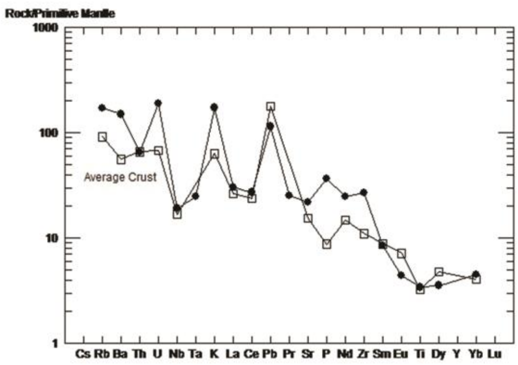

Fig. 13. Comparison of the average pattern of trachy-andesites of the region of continental crusts.

The relations of K2O/P2O5 in trachiandesites of the region is 6/5 on average and are mainly basaltic magmas originated from mantle-derived basaltic magmas having the relation ≤2 K2O / P2O5. But assimilation of continental crust or apatite fractionation leads to an increase in the latter one, and this issue has been observed in basalts of Columbia River in west of America (Carlson and Hart, 1988). Because positive P anomalies have been observed in spider charts of the rocks of this area and also in thin sections the apatite minerals have been visible, so this relation above K_2O/P_2O_5 is not resulted from apatite fractionation and as a consequence the reason for the rise in the above mentioned, is the assimilation of rocks of continental crust and this issue can explain the high quantity of potassium and formation of false Shoshonitic nature of the rocks. Relations of Ce/Pb and Nb/U in magma basalts are sources of non-contaminated mantle (MORB+OIB) are noticeably fixed and are respectively 25 ± 5 and 47 ± 10 (Hofmann *et al.*, 1986). While the average of Ce/Pb and Nb/U in the continental crust are 3/9 and 6/2, respectively, in the rocks of these two areas these relations are 6/9 and 3/5 respectively and their being low show magma's involvement with the continental crust (Jung, 1999).

One can identify the geotectonic formation of rocks from their chemical compositions (Gao, 2006). In Fig. (14) in Zr/Y chart next to Zr of (Pearce and Norry, 1979), the region's rocks are located in the range within the plate. In Fig. (15) in algorithmic chart of Th/Hf next to Ta/Hf of (Wang *et al.*, 2001) all the samples have been located in IV range meaning that basalts within the continental plate and in section IV_3 meaning elastic belts within the continent basalts and or continental initial rifts. Similarly in Th/Zr chart next to Nb/Zr of (Shuqing *et al.*, 2003) samples are located within the elastic continental zone or initial rift (Fig. 16).

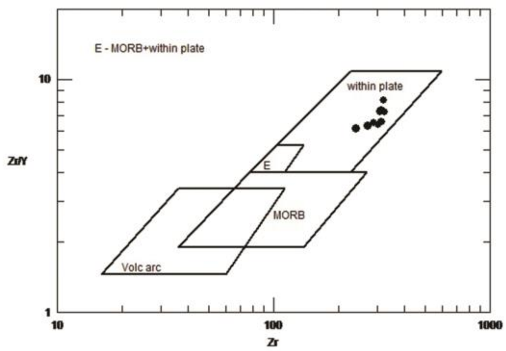

Fig. 14. The position of area's sample in Zr/Y versus Zr of (Wang *et al.*, 2001).

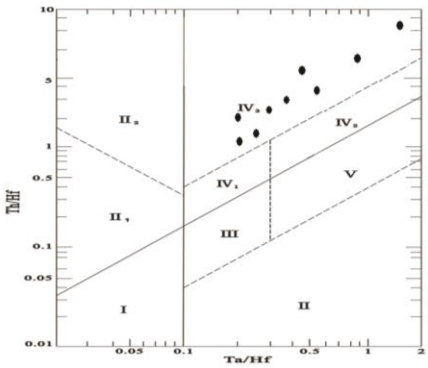

Fig. 15. The position of samples in the charts Th/Hf-Ta/Hf of (Wang *et al.*, 2001).

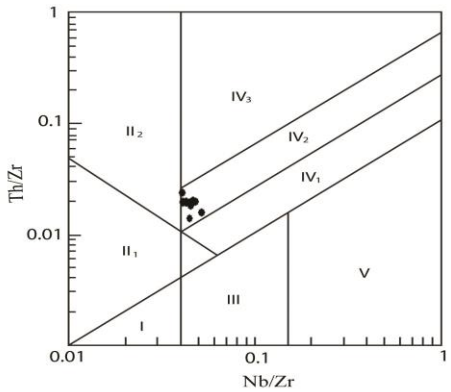

Fig. 16. The position of samples in the charts Th/Zr-NbZr of (Shuqing *et al.*, 2003).

The fields are as follows: I. The N-MORB area at convergent plate margins, II. The basalt area at convergent plate margins, II$_1$. Oceanic Island-Arc basalt area, II$_2$. Volcanic basalt arcs and continental margins and island of arc-continental margins, III. Oceanic islands with inter-continental plates, the basalt Seamount and the T-MORB and E-MORB areas, IV. Inter-continental basalt area [IV1 regional and tholeiitic areas with inter-continental margins, IV2 inter-continental alkaline basalt rift region, IV3 continental elastic belts (primary rift basalt area); V. The basalt mantle Plume area; Are the region's Trachyandesites, In Fig. (17) in the algorithmic chart K_2O/Yb next to Ta/Yb of (Pearce, 1982) samples are interestingly located within the plate basalts range, they have shown a process from the mantle array process toward the transitional tholeiitic basalts and follow the enriched mantle and crustal component (vector E). In Fig. (18) the average pattern of continental tholeiitic andesite in the region with average mean values and upper continental crust have been compared with each other. It seems that the original magma forming continental tholeiitic was similar to that of the upper continental crust rocks have been affected to some degree. According to (Didon and Gemain, 1976) crack of platform Azerbaijan (the area under study is located in the eastern part) at the end of the Cretaceous and transmission of this divide from north to south and also the characteristics of alkaline volcanic rocks testify to the opening and development of a continental rift which are shown in further southern parts by (Sabzehei, 1974) and (Amidi, 1975). This rift in Eocene is related to the presence of a thermal dome below Azerbaijan.

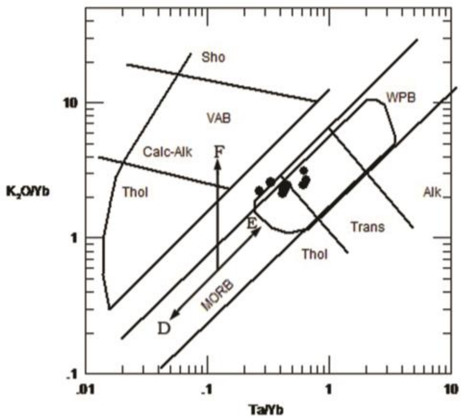

Fig. 17. The position of samples the in the chart K2O/Yb of (Pearce, 1982).

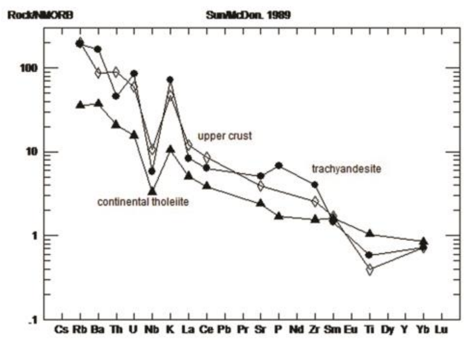

Fig. 18. The comparative pattern of the area's trachyandesites means with those of The upper crust and continental tholeiites. Continental tholeiites ▲ upper crust ◊ region' s trachyandesites ●

Conclusion

This rift is the continuation of a series of massive volcanic within continental north that has passed through the whole country. But this rift has expanded very quickly along Mianeh-Ardebil line where three zones: 1. Tarem mountains zone, 2. Eastern Azerbaijan zone and 3. Mianeh-Ardebil zone are detectable. In Fig. (19) comparison between the model elements of the tranchandesite incompatible with the Afar rift tranchyandesite of the upper continental crust and the normalized mean values of the kind [N8] are shown in italics. Patterns of similarity between the Afar rift with rocks and coordination process trachyandesite element with the continental crust is clear. According to the authors geotectonic pattern of Eocene volcanism in this area is similar to that of inter-continental rifts so that our research shows that primary magma continental tholeiitic trachyandesite of the same region in which an inter-continental rift environment emanating from the upper continental crust rocks have been affected to some degree. We believe that the potassic feature is not of the characteristic of the origin zone but crustal contamination leads to rise in magma potassium and the formation of potassic series and false Shoshonites in the rocks of the region.

Reference

Amidi SM. 1975. Contribution a letude stratigraphique, petrologique, et petrochimique des roches magmatiques, de la region de Natanz - Nain- Surk (Iran central), These. Doct . Etat, Grenoble.

Carlson RW, Hart WK. 1988. Flood basalt volcanism in the northwestern United States.

Cox KG, Bell JD, Pankhurst RJ. 1979. The interpretation of igneous rocks. George, Allen and Unwin, London.

Cox KG, Hawkesworth CJ. 1985. Geochemical stratigraphy of DecanTraps, at Mahabalshwar, westrn Ghats, India, With implications for open system magmatic processes. Journal Petrolology **26** , 355-377.

Didon J, Gemain YM. 1976. Le Sabalan, Volcan Plio-quaternair de l'Azerbaidjan oriental (Iran); etude geologique et petrographique de l'edifice et de son environnement regional, These de 3eme Cycle, Univ. Grenoble 304 P.

Fodor RV. 1987. Low and high – TiO_2 flood basalts of southern Brazil. Origin from picritic parentage and a common mantle source. Earth planet. Journal of seientic Letter **84**, 423-430.

Gao J. 2006. Geochemical discrimination of the geotectonic environment of Basaltic-Andesitic volcanic rocks associate with the Laochang polymetallic ore deposit at Lancang, Yunnan, Chinese Journal of Geochemistry **25(4)**, 402-407.

Hofmann AM. 1997. Mantle geochemistry: The message from oceanic volcanism, Nature **85**, 219-229.

Hofmann AW, Jochum KP, Seufert M, White WM. 1986. Nd and Pb in ocanic basalts, New constraints on mantle evolution, Earth". Planet. Sci. Lett **90,** 297-317.

Irvine TN, Baragar WR. 1971. A guide to the Chemical Classification of the Common Volcanic Rocks", Canadian J. of Earth Sci **8**, 523-546.

Jaques AL, Creaser RA, Ferguson J, Smith CB. 1985. A review of the alkaline rocks of Australia. Trans. Geol. Soc. S. Afr **88**, 311–334.

Jung S. 1999. The role of Crustal Contamination during the evolution of Continental rift-related Basalts. A case study from the Vogelsberg area (Central Germany), Geolines (Praha) **9**, 48-58.

Lescuyer JL, Riou R. 1976. Geologic de la region de mineh (Azerbaijan) Contribution a l'etude du volcanisme tertiaire de l'Iran. These de 3eme Cycle Grenoble 233 p.

Miyashiro A. 1974. Volcanic rock series in Island arcs and active Continental margins, American Journal of Science **274**, 1974, 321-355.

Muller D, Rock NMS, Groves DI. 1992. Geochemical discrimination between Shoshonitic and Potassic Volcanic rocks in different tectonic setting: a pilot study, Mineralogy and Petrology **46**, 259-289.

Pearce JA, Norry MJ. 1979. Petrogentic implications of Ti, Zr, Y and Nb variations in volcanic rocks". Contribution of mineralogy and petrology **69**, 33- 47.

Pearce JA. 1982**.** Trace element characteristics of lavas from destructive plate boundaries, in: Thrope, R.S.(ed) Andsites, wiley, chichester 528-548.

Rollinson HR. 1993. Using Geochemical Data: Evolution, presentation, Inter pretation" Longman scientific and technical, England 352 p.

Rudnick RL, DM Fountain. 1995. Nature and composition of the continental Crust: Alower crustal perspective. Review Geophysics journal **33**, 267-309.

Sabzehei M. 1974. Les mélanges ophiolitiques de la region d'Esfandagheh (Iran meridional)", Etude pétrographique et structural. These Doc. Etat, Univ. Grenoble 306 p.

Shuqing S, Yunliang W, Chengjiang Z. 2003. Discrimination of the tectonic sitting of basalts by Th, Nb and Zr, Journal of Geology Research **49**, 40-47.

Sun SS, McDonough WF. 1989. magmatism in the oceanic basalts" (Saunders AD and Norry MJ, Her ausgeber), Geological society. special publ **42**, 313-345.

Taylor SR, McLennan SM. 1985. The continental crust: Its composition and evolution, Blackwel sci. pub. Oxford 312 p.

Wang Y, Zhang C, Xia S. 2001. Th/Hf-Ta/Hf identification of tectonic setting of basalts, Acta Petrologica Sinica **17**, 413-421(In Chinese with English Abstract).

Wilson M. 1989. Igneous petrogenesis. Unwin Hyman, London 1989.

Winchester JA, Floyd PA. 1977. Geochemical discrimination of different magma series and their differentiation product using immobile elements", Chemical Geology **20**, 325-343.