INNSPUB

Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print), 2222-3045 (Online)
http://www.innspub.net
Vol. 5, No. 6, p. 345-352, 2014

RESEARCH PAPER OPEN ACCESS

Petrology and geochemistry of volcanic rocks in south Langrood

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Key words: Calc-alkaline, Geochemistry, Petrology, Rift, Shoshonite, South Langrood, Tholeiitic.

Article published on December 16, 2014

Abstract

This region is located 330kmfar from north of Tehran in Gilan province. According to tectono-sedimentary classification of Iran (Nabavi, 1977), this region is located in Alborz-Azarbaijan zone. The area of understudied region in Gilan province is 450 km^2 that is located in south and west part of Amlash city. In this region the upper part is formed of an Ophiolite set that its uplifting time is upper Cretaceous. Constitutive rocks of this part are rocks of old ocean crust and totally consist of carbonate cretaceous sedimentary rocks, pillow basalts (include basalt, basaltic andesite, andesite and trachyte terms), delorite and gabbro dikes. Totally it can be concluded that petrologic and geochemical studies in southern of Amlash indicate a magmatic event in various tectonic environments in a way that each rift environments, active continental and intra-plate margins are acceptable for some of the samples. In the other hand, there are evidences that show magmatic differentiation and crust pollution happened in understudied rocks. Therefore, clear and detailed interpretation about tectonic environment of these magmatic events is not possible.

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Introduction

Under studied region is located in Gilan province, in south of Langrood city, Amlash town, among 50° 30' and 50° 00' Eastern longitudes and 37° 15' and 37° 00' Northern latitudes. Its area is about 450 km^2. According to classification of Iran structural zones, this region is located in Alborz-Azarbaijanzones (Nabavi, 1977). Access ways to this region is from main road of Tehran, Rasht, Lahijan, Langrood, Amlash, Roodsar (Fig.1).

In this region the upper part is formed of an Ophiolite set that its uplifting time is upper Cretaceous. Constitutive rocks of this part are rocks of old ocean crust and totally consist of carbonate cretaceous sedimentary rocks, pillow basalts (include basalt, basaltic andesite, andesite and trachyte terms), delorite and gabbro dikes.

Fig. 1. Geographical status of understudied region (guide map of Gilan province with 1:565,000 scale, Gytashenasi institute).

Metamorphism has appeared as regional alternation at *green schist facies*and dynamic metamorphism (cataclastic and mylonite). Existed Pelagic limestones in the region primarily appear as interlayers material in the upper side of pillow lavas with low frequency; gradually their frequencies increase toward top of sequence and eventually form an independent unity above the pillow lavas. On the basis of existed microfossils, the limestone has old cretaceous age. In this region the main procedure of buildings' side effect is (faults and rifts) western north- eastern south. Mineralogical and chemical components of Igneous rocks form in the source location (mantle, crust) and change when magma moves toward the Earth's surface and places in surface layers; therefore, main and rare components are controlled by some factors such as melting, wall rock reaction, crystallization etc.

Regarding geological map, a progressive conglomerate is seen in the base of destructive sequence including thin to thick layers sandstones, dark gray shales along with coal signs. Late cretaceous sedimentary in this region had happened with wide volcanic activity that led to huge amount of volcanic rocks with alkaline compounds. The outcrop volcanic unit in the region includes gray to dark green volcanic rocks.

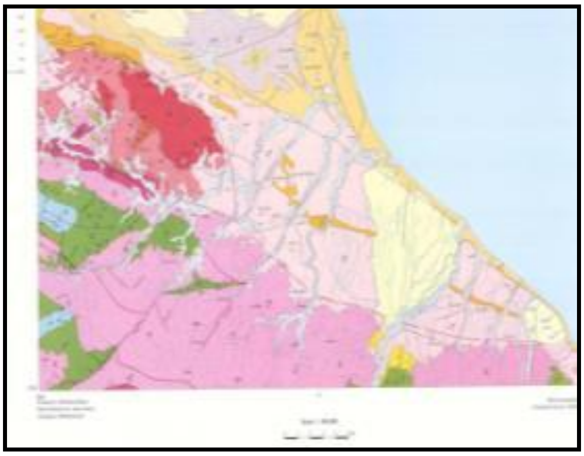


Fig. 2. Geological map of understudied region (adopted from geology map 1:100000 Langrood page). Understudied region has pink color.

Regarding field studies the most frequent rocks of this region mostly appear in the form of pillow lavas and basaltic magmas (Fig. 3).

The textures of these rocks are porphyritic with glomeroporphyritic and microlitic dough. Clinopy-roxenesare mostly shaped to semi shaped, but are altered and transformed to chlorite ,oralyte andepidote in a way that sometimes their rests have remained.

In addition, other rocks such as basaltic andesite, andesite, andesite teriyaki and gabbro are present in this region. Basalts with pillow Debiare frequently observable in most zones.Erosion and alternation are developed in them and erosion face is soft (fig. 4). The samples of basalts have dark brown, green and black colors. In vacuolar samples, the rock's pits are full of calcite, dolomite and zeolite. Rocks' main deposits include olivine, pyroxene with types of ojete and plagioclase; and subsidiary deposits are opec, zircon and osfen. Secondary deposits include serpentine, oralyte, chlorite, epidote, calcite, zeolite and sericitethat show differences in various samples.

Andesitic rocks are gray and their textures are porphyritic with microlitic dough (plagioclasemicrolite) and phenocrysts include plagioclase and pyroxene (low amount). Plagioclases show polysyntheticMacle and Carlsbad (Fig.5f) and have been altered to chlorite and sericite. Pyroxenes are mostly semi shaped and completely decomposed, only some rests remain and are completely transformed tooralyte and chlorite. Sometimes, opec deposits are aspoikilitic form and places inside the plagioclases.(Fig. 5a,5b,5c,5d). The aim of the study is Petrology and geochemistry of volcanic rocks in south Langrood and determination rock types and tectonic environment.

Fig. 3. The view of pillow lava in Otaghvar-Layl region (face is toward the east).

Fig. 4. The view of basalt with soft erosion Debi.

Materials and methods

Geology of understudied region

According to structural geology point of view, the understudied region is located in Alborz-Azarbaijan zone (Nabavi, 1977). This zone includes regions that have limited Caspian Sea coastal line and is located in north side of Alborz fault. Regarding Eftekhar-Nejad's (1981) classification, the major parts of this zone is named Caspian Sea's subsidence region (Darvish-Zadeh, 1992).

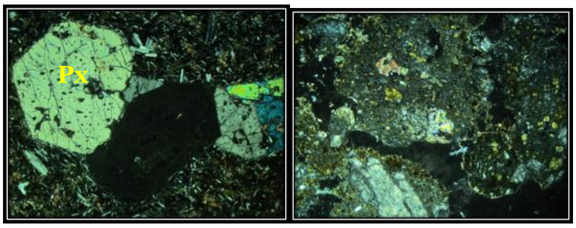
Research method

Our research includes two parts: field work and laboratory investigations. Field work includes sampling from volcanic rocks for analyzing REEs. In the course 50 thin section preparation and was studied with petrographic polarizing microscope. Some of the fresh rocks selected for ICP-MS and XRF analysis. The analyses were made in Acme Laboratory in Canada.

Result and discussion

Basaltic andesite rocks

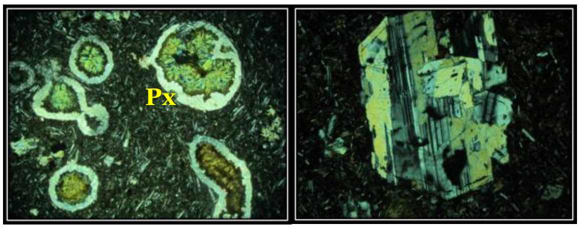
The textures of these rocks are porphyritic with microlitic dough. Macro crystals in rocks includeplagioclases and pyroxene (with low frequency). The rock's dough consists of plagioclase microlitic. Pyroxene and plagioclase phenocrystals are observable in aphanitic setting.(Fig. 5e,5f).



(a) (b)

Fig. 5a. Microscopic picture of basaltic samples that have porphyritic with microlitic dough texture in XPL light.

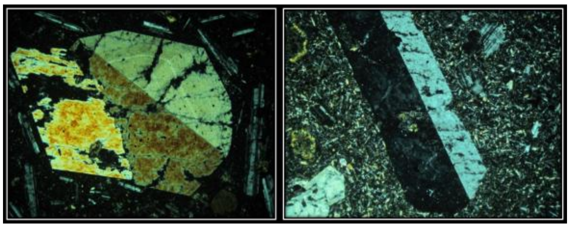
b. Microscopic picture of basaltic samples that have porphyritic with microlitic dough texture in XPL light.



(c) (d)

Fig. 5c. Microscopic picture of basaltic samples that have hyloporphyritic texture in XPL light.

d. Microscopic picture of basaltic samples that have porphyritic with microlitic dough texture in XPL light.



(e) (f)

Fig. 5e. Microscopic picture of basaltic andesite with macle hourglass that has porphyritic with microlitic dough texture in XPL light.

f. Microscopic picture of a Sundine in andesite that has porphyritic with microlitic dough texture in XPL light. (In all the subsections fig. 5 the scope length is 4mm).

Geochemistry

In primary studies, first a review on existed literature and scientific works relating to understudied region was done. Early inspection for becoming familiar with region's geological status was done. Toward this, sampling of 100 samples was done and their status was recorded by GPS device. Thirty of samples were analyzed and decomposed to main and subsidiary elements by the method of ICP-MS and XRF. Then they were processed by GCDkit software. Then samples were studied by different graphs.

Chemical nomination of understudied rocks

In the graph, total numbers of alkaline by silica (LeBas*et al.*, 1986). Samples of understudied region have been placed in the range of basalt, teriyaki basaltic andesite, andesite and dacite.

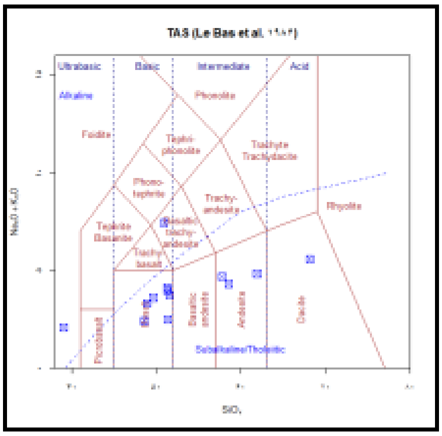


Fig. 6. The status of Bazik samples and middle part of region, in graph total numbers of alkaline by silica (Le Bas *et al.*, 1986).

To classify extracted rocks normative trinary Ab-An-Orgraph (Oconnor, 1965) was used, according to this graph the most frequent sample was felsic in dacite range (Fig. 7).

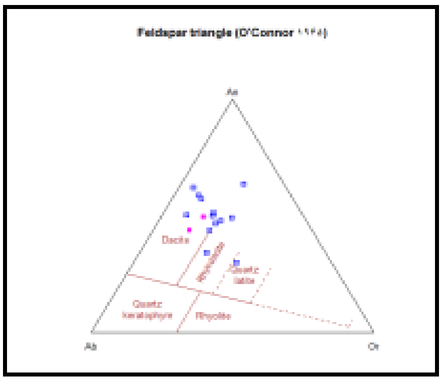


Fig. 7. The status of extracted samples in trinaryAb-An-Or graph (Oconnor, 1965).

Determination of magmatic series

To study magmatic series of understudied rocks in south Langrood region Irvin and Bargar's (1971) graphs was used and the graph of K_2O by SiO_2 was used (Peccerillo & Taylor, 1970). On the basis of Peccerillo and Taylor's (1970) graph, samples classified in the range of calc-alkaline and high potassium calc-alkaline and two other samples are located in shoshoniteseries. In Irvin and Bargar's (1971) graph, most of the samples are placed in tholeiiti series.

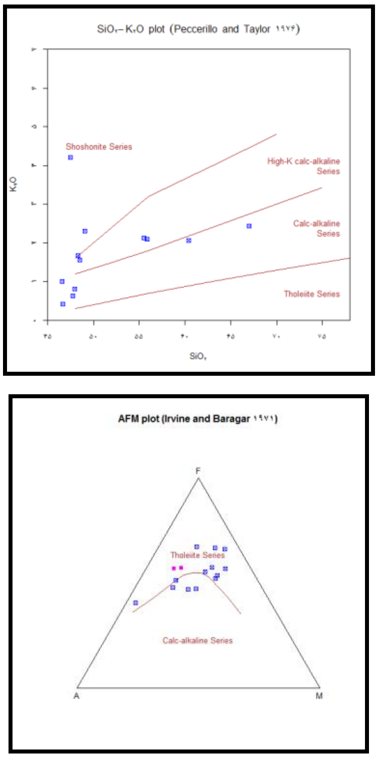


Fig. 8. The status of Bazic and middle part samples in the graphs of (Peccerillo & Taylor, 1970) and (Irvin and Bargar's, 1971).

Considering the graphs of changes in main and subsidiary elements

To study the process of elements changes during magmatic evolution Powers (1955) suggested using MgO. The reason of suggesting this oxide is that in most of the natural igneous systems, the solid and crystalizing phase of magma has more MgO than liquid and melting phase. But the fact is that MgO is only proper for identifying differentiate process of Bazik samples. Moreover, in specific conditions, simultaneous crystallization of Mg deposits such as Olivine and Pyroxene with non-Mg deposits such as Magnetic and plagioclase leads to inversion of MgOdepletion phenomenon (Cox *et al.*, 1979).

Regarding Wilson (1989), graphs of changes in chemical elements show chemical evolution of magmatic lavas and indicate compound changes of lavas as a result of some processes such as crystallization, melting and contamination. In the present study, because of dikes' bazik nature and changing domain of MgO, MgO index was used as differentiate coefficient and changes in main and subsidiary elements are evaluated on its basis.

As it is observable in the graph of Cr by MgO, Cr is considered among Large Ion Litophil. Changes of elements that are correspondent to Cr against Mg showed that by increasing differentiate process and reducing MgO amount, the content of those elements that are compatible to Cr decreased.

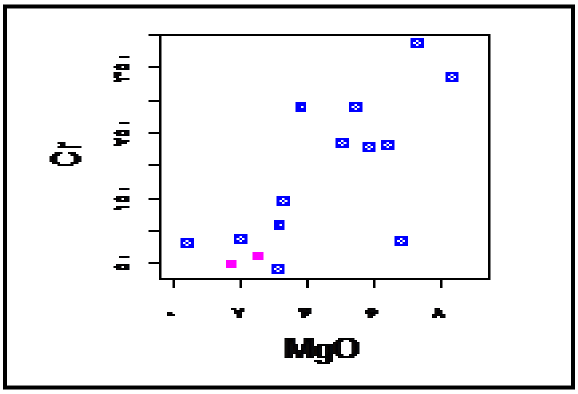


Fig. 9. Changes graph Cr by MgO.

The study of spider graphs

Negative Ta and Nb a-normalcies are manifest feature of sub-ducted regions (Wilson, 1989). But these disorders can be clearly seen in continental mutiny basalts and rift region of intercontinental basalts that are polluted by continental crust (Wilson, 1989).

Regarding Rollison (1993) negative Nba-normalcy is the index of continental rocks and may be the sign of crust's participation in magmatic processes. Totally, positive Pb and negative Nb-Ta a-normalcies are manifest features of continental crust (Taylor and McLennan, 1985).The pattern of rare elements of region's trondhjemite, that are normalized with primary mantel materials and N diagonal materials are shown. As it is observable, extreme negative Ti, Nb, P, Eu and Ba abnormalcies and positive Th and K abnormalcies are clearly shown. Regarding this pattern the elements of Th, U, K, Rb and Cs have more enrichment than primary mantle. Enrichment of this region's basalts from LILE can probably attribute to magmatic differentiation and crust pollution.

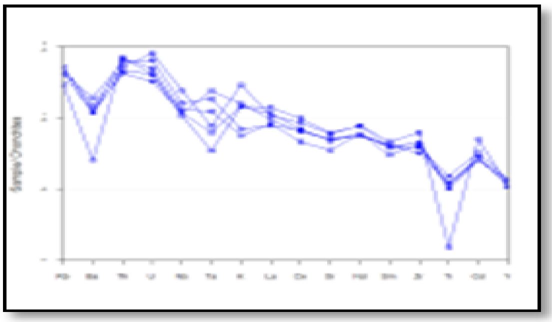


Fig. 10. The spider graphs of normalized Langrood basalts in comparison with primary mantle (Sun &McDonough, 1989).

In Fig. 11, the pattern of rare elements of region's basalts in comparison with upper continental crust that are normalized with N-MORB is shown. As it is observable Amlash basalts show some enrichment of LREE rather than HREE.

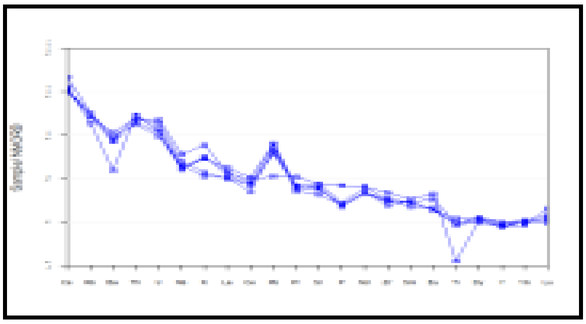


Fig. 11. The graph of region's basalts that become normalized with N-MORB (Pearce, 1983).

The study of REE elements pattern

In Fig. 12, the pattern of REE elements of Bazik and middle part samples that are normalized with Chonderiteis showed (Sun & McDonough, 1989). Amlash basalts show some depletion from Ti and Ba, and enrichment with Pb. Most of the elements place above standard line of 1 i.e. MORB, this shows their independency to depleted mantle source (MORB). It can be concluded that the pattern of normalized multi elements or spider graphs with Chonderite, diagonal and primary mantle relate to all the graphs that show enrichment with some elements such as U, Pb, Th and Cs and is the result of crust pollution and differentiation.

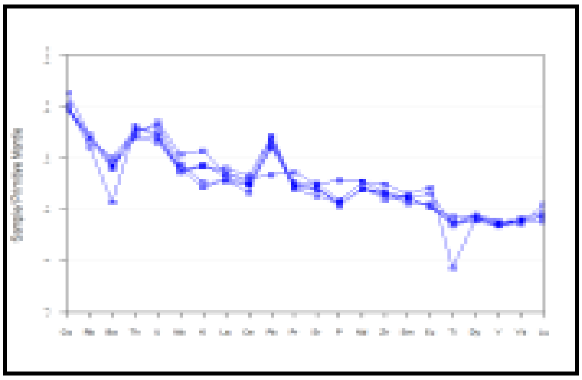


Fig. 12. The graph of changes in REE elements of normalized Langrood basalts than Chonderite (Sun *et al.*, 1980).

Petrogenesis and geological status

To determine geological source of region's rocks, geochemical graph was used and the results were correspondent with field studies and microscopic evidences. Regarding Triangulargraph of K_2O- TiO_2-, Ti/100-Zr-3*y and Ti/100-Zr-Sr/2 (Pearce &Norry, 1973), two graphs of middle-Bazik rocks of Amlash are placed in the class of Calc-Alkaline (CAB).

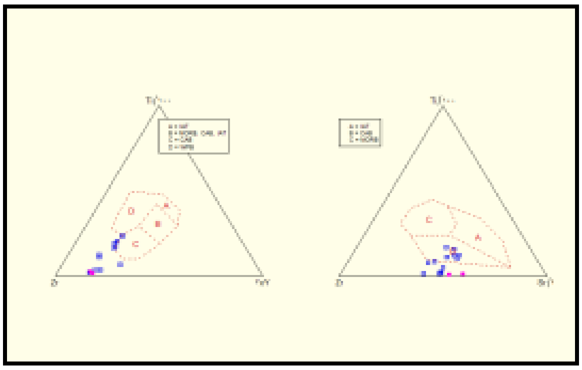


Fig. 13. Triangular graph of Bazik igneous rocks on the basis of Ti/100-Zr-3*y and Ti/100-Zr-Sr/2 (Pearce &Norry, 1973).

Tringular graph of MgO-FeO-Al_2O_3 (Pearce *et al.*, 1977) used for volcanic rocks which their silica domain is between 51-56 weight percentages; i.e. for sub alkaline basalts and basaltic andesite. Regarding this graph, most of the Amlash samples such as basalts and sub alkaline andesite place in developing zones, ridges, ocean floor and continents. Totally in this graph a scattering of zones can be observable.

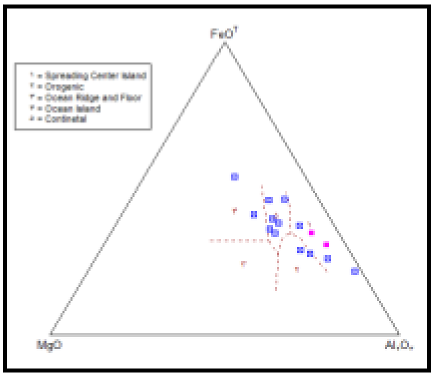


Fig. 14. Samples status in triangular graph of MgO-FeO-Al_2O_3 (Pearce *et al.*, 1977 cited in Rolinson, 1993).

Triangular graph of Zr-Nb-Y (Mashd, 1986) is on the basis of Zr-Nb-Y amounts in which most of the samples place in alkaline range of intraplate basalts.

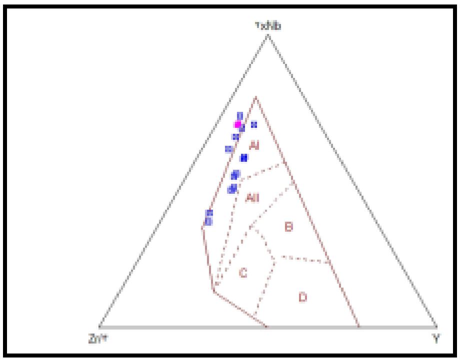


Fig. 15. Separating graph of tectonic environment (Mashd, 1986).

Conclusion

On the basis of field studies, microscopic and geochemical evidences on South Amlash's samples following nomination was done for understudied samples by geochemical methods: swinging zoning in plagioclases, various generation of plagioclases, congress margin of plagioclases, partial or complete dissolute regions around plagioclases; after drawing TAS (1986) diagrams that is specific for volcanic rocks, all the samples are categorized in basalt, basaltic teriyaki andesite, andesite and dacite. Totally it can be concluded that petrologic and geochemical studies in southern of Amlash indicate a magmatic event in various tectonic environments in a way that each rift environments, active continental and intra-plate margins are acceptable for some of the samples. In the other hand, there are evidences that show magmatic differentiation and crust pollution happened in understudied rocks. Therefore, clear and detailed interpretation about tectonic environment of these magmatic events is not possible.

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