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PETROLOGY AND THE ORIGIN OF THE INTRUSIVE MASSES OF THE EAST OF JIROFT

PETROLOGIA E ORIGEM DE MATERIAIS INTRUSIVOS NO LESTE DE JIROFT

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ABSTRACT

The study area with an area of 55 km^2 is located south east of Kerman province and in the area of Jiroft city. This area is structurally and geological division in the Urmia-Dokhtar zone. The Urmia- Dokhtar volcanic belt part of the Alpine-Himalayan is a volcanic belt. Several intrusive bodies are in the east of Jiroft, which is part of Jebalbarez Batolite andigneous actives of JabalBarez area have occurred in four stages. The third magma activity of the region occurred in Oligomiocene and occurred during three phases. its lithological composition includes synogranite and Monzogranite, granodiorite, diorite, quartz monzonite. Quartz, Plagioclase and Potassium feldspar are the major minerals in granites. Biotite, Amphibole, espen, opac minerals are other manufactores of these rocks. Various types of granular, myrmekitic, Graphic and perthite textures are observed in them. Regarding field studies, petrographic, and geochemical studies, granite rocks of meta-aluminum and granitoid components of Iseries are volcanic arc of the continental margin of orogenic region that originate from melting of shell-shaped igneous rocks. granitoid specimens are normalized to the original mantle, chondrite, upper and lower crust. The samples show enrichment LREE and less enrichment of HREE. The composition of the samples in terms of these incompatible elements is similar to the medium composition of the crust. Samples in tectonic environment diagrams are located wothing the VAG range. igneous rocks are associated with the subduction zone neotethys. The magma subtraction in the magmatic room in the first stage leads to the formation of quartz- diorite to granodiorite composition, and in the second phase, with the continuation of magmatic subtraction, the magma composition is more acidified than before and the rocks with granodiorite to granite composition composed. In the third stage, with the continuation of the subtraction process, the composition of magma is highly acidic consists of granite and alkali granite stones.

Keywords: Petrology of Intrusive Population; Urmia-Dokhtar; Jiroft; Iran.

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INTRODUCTION

The Urmia-Dokhtar volcanic belt part of the Alpine-Himalayan is a volcanic belt. Generally, according to previous studies, the igneous actives of JabalBarez area have occurred in four stages (GORBANI, 2014). The first stage of magmatic activity is Jurassic, the result of which is the formation of granitic rocks (description of the Sabzevaran map's, DIMITRIJEVIC, 1973). This stage has a predominantly activity and it`s rocks include Andesite and Andesi basalt, rhyodacite, rhyolite porphyry and depended pyroclaste (GORBANI, 2014). The third magma activity of the region occurred in Oligomiocene. This magma activity is widely responsible for the formation of intrusive rocks, and all the intrusive complexes discussed in this article are also included in this group.

The third itself, the intrusive magmatic activity of the Oligomiocene, occurred during three phases (VICTIM, 1993). The first phases consist of a dominate and most dominate body with a quartz-dyuorite-granodiorite petrography compound. After a sheet time interval and subtraction of magma whiting the magmatic nest, porphyry masses penetrate in this major plutonium complex. The petrography composition of these masses is more granodiorite than granitic. These porphyry massifs are the second magmatic phase of the region during the oligimiocene. Again, after a short time, the last phase of the magma Oligomiocene (phase III) occurred (GORBANI, 2014).

The intrusive masses of the third phase pfOligomuccene, which have a granular alkaline composition, have been injected into the intrusive masses. The fourth stage of magma activity in the under discussion is related to quaternary basalts. Of course, these rocks do haven`t much to be explored in the study area (GORBANI, 2014).

DISCUSSING

The study area with an area of 55 Km, it is in southeast of Kerman province, in the area of Jiroft city. The area is between the latitude of 28° 30′ North to 58°15′ and longitude 57° 45′ to 58° 15′ east. The above-mentioned area is in the east of the geological map of 1:100:000 and 1:250:000 Sabzevaran and west of the Geological map of 1:100:000 to the Jebalbarez (Figure 1).

The JebalBarez complex, is approximately 50 Km. long in the southern part of the copper belt in Kerman, the rocks of this complex have a granitoidcompound. In Jebalbarez area, magmatic activity has been found internally and externally. Generally, according to provious studies, the igneous activities of JabalBarez area have occurred in four stages (GOURBANI, 2014). The third magma activity of the region occurred in Oligomiocene. This magma activity is widely responsible for the formation of intrusive rocks, and all the intrusive complex discussed in this paper, also included in this group. The third stage, the intrusive Magmatic activity of the Oligomiocene, occurred during three phases (GOURBANI, 2014). The total volume of rocks in the region is granodiorite, synogranite, monzo-granite, quartz monzonite, quartz-monzoniteand-diorite.

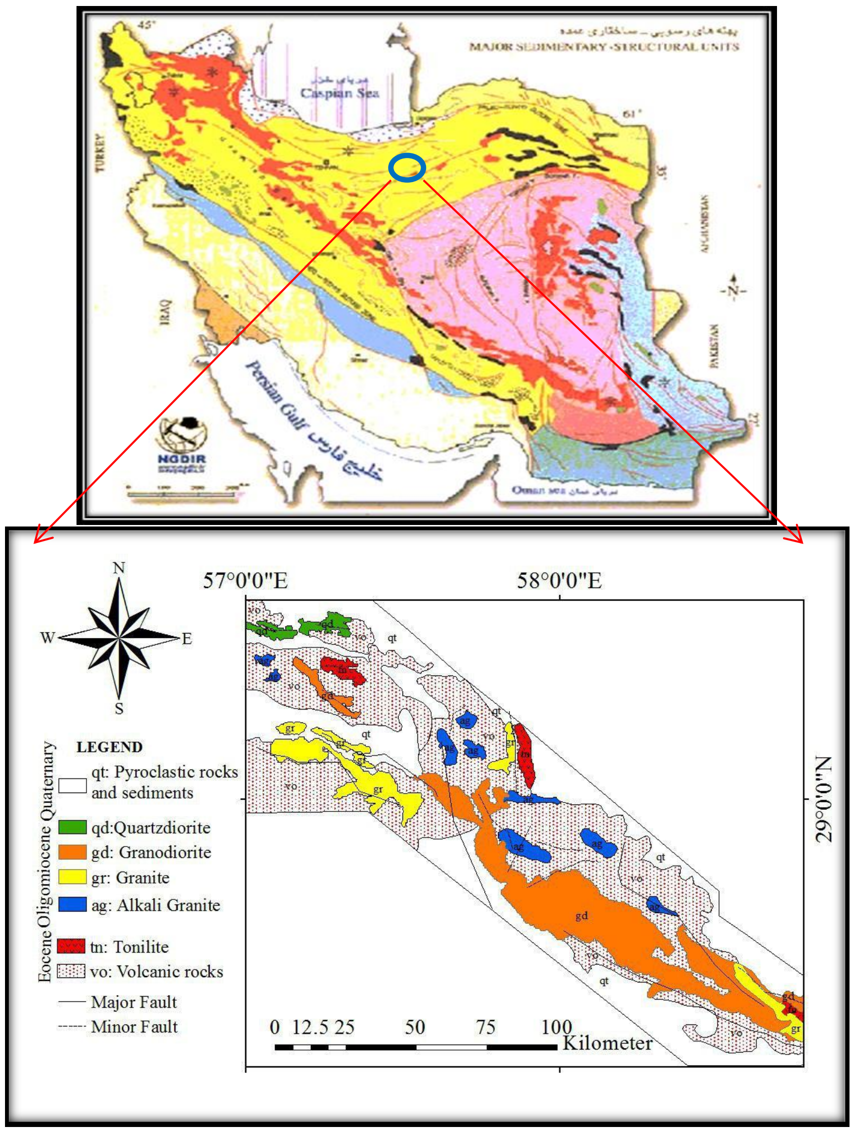

Figure 1: Geological map of granitoid masses of JabalBarez
Derived from Geological maps of Namashir, Sabzevaran and Bam with Faridy and Attar corrections, (2003); Aghanabati and Eftekharnejhad (1994); Dimitrijevic (1973).

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PETROGRAPHY

From the perspective of petrology, the Granitiod masses of the region have a petrologycomposition on the range of synogranite, monzonite, monzo-diorite, granodioriteand monzo-granite.

A. synograniteandmonzo-granite

In samples, granular, graphic, veins perthiteare seen (Figure 2A) and plagioclase crystals have often been sub-automorph and sericite. In Plagioclases, twinning sinusoid, carlsbad and polysantetic with swinging zoning are observed. From their subsidiary minerals, they can be mentioned as opac minerals and from secondary minerals to sericite, iron oxide (hematite) and chlorite. The main constituent minerals are respectively frequency, including quartz (30-35%), potassium feldspar (25-20%), Plagioclase (925-20%) and amphibole and their minor minerals include Sphen, Zircon, Apatite, Biotite and OPAC minerals (primary and secondary).

b. Granodiorite

These rocks are less widely distributed in the than other types. The bright minerals of these rocks include Plagioclase (55-45%), Quartz (22-20%) and Feldspar- potassium (18-10%) in small amounts, and minor minerals include biotite, amphibole, espenand opac. Chlorite, epidote and sericite minerals are secondary minerals. Their microscopic textural is granular sub-hedral (semi arranged grains), poeicliticand graphic (Figure 2B) .

c. Diorite

These rocks are widely distributed in the region than other types. The bright minerlas of these rocks include plagioclase (55-45%), quartz (22-20%), and Feldspar- potassium (18-10%), and minor minerals including biotite, amphibole, espenand opac. chlorite, epidote and sericiteminerlas are secondary minerlas. Their microscopic texture is granular sulfide (semi-arranged grains), poeiclitic and graphic (Figure 2C).

D. Quartz-monzoniteandmonzo-diorite

These rocks are all crystalline and medium to fine grained, and they can be found in hornblende and feldspar minerals. In microscopic sections, their dominant textures are porphyry,

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inter-granular, and granular (medium to coarse grains) and sometimes show clay poetic texture. Main minerals include Plagioclase (50-45%), feldspar alkaline (22-15%), hornblendeand quartz (less than 10%), minor minerals include Pyroxene, apatite, and opac minerals and secondary minerals including espen, chlorite, epidote, sericiteand clay minerals (Figure 2D).

H. Quartz-monzonites

The main texture of these rocks is granular, inter- granular, and poeiclitic. The mineral content of plagioclase is between 35-45% and feldspar alkaline 25-35% and quartz is about 10%. hornblende with a frequency of 10% and its approximate size various from 0.2 to 2 mm. apatite, espen and subsidiary mineralsand secondary minerals include sericite, biotite, chlorite and calcite (Figure 2).

GEOCHEMISTRY

Selected samples of intrusive bodies are included in the chemical classification diagram (MIDDELMOST, 1985) and De La Roche (1980) in quartz monzonite, granodiorite, monzo-granite and quartz- monzogranite (Figure 3a-b). Several graphs have been used to identify the crystallization processes of minerals in the rocks studied.

In Shand diagram (1994) granitoidgems are in range of peraluminium and in the Miyashiro (1974) and Ying *et al.* (2007) graphs in the range of calk-alkaline with moderate iron content (Figure 5a).according to the graph Zr+Nb+Y vs. Na_2O+K_2O/CaO (WHALEN *et al.*, 1987), the granite samples studied in the range of granites (OGT) and less FG and in the Y diagram in contrast to SiO_2 (FURNES *et al.*, 1996), granites are of type I (Figure 4C and D).

Granitoid specimens are normalized to the original mantle and chondrite. In this chart, we see (Figure 5a), the samples show enrichment LREE and less enrichment of HREE. But in spider diagrams that are normalized to the upper and lower crust (Figure, 5c and d). We find that the composition of the samples in terms of these incompatible elements is similar to the medium composition of the crust. Although in the elements of Uranium and torium enrichment is up 100 times, and considerable depletion occurs in zirconium.

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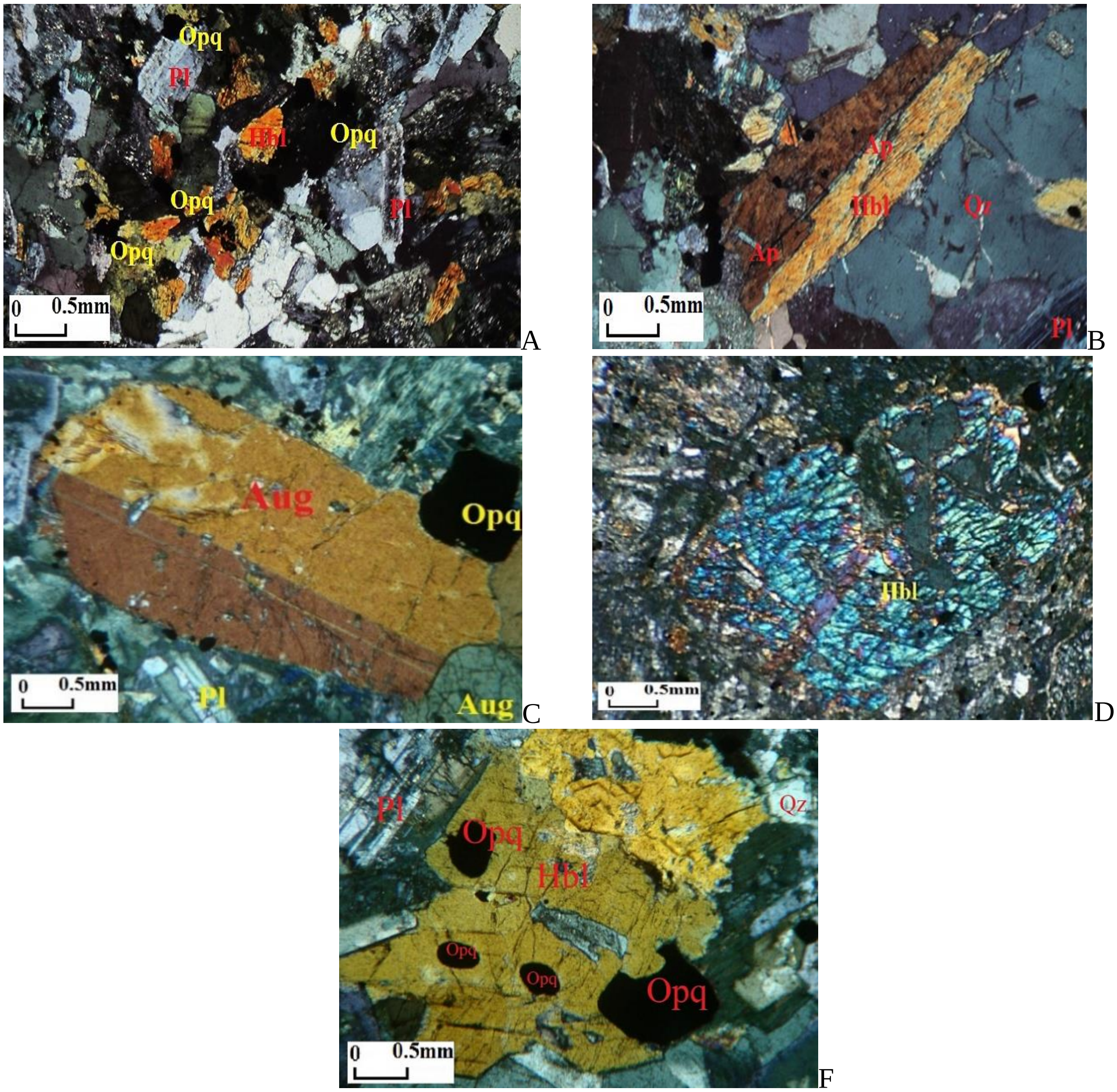
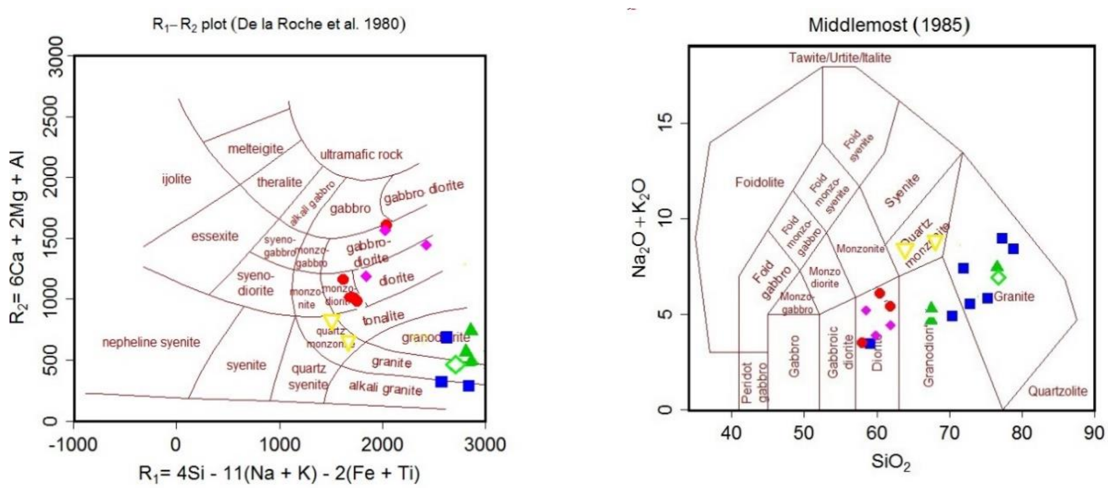


Figure 2: A: Granular texture and abundance of initial opac minerals in monzogranite;
B: Granular and poeiclitictexture due to the presence of apatite in Hornblende in granodiorite;
C: granular texture and hornblendechloritesin diorite;
D: porphyry texture and hornblende chlorites in Monzonite.
F: the granular and poeiclitictexture in quartz monzonite.



diorite:monzo-granite:synogranit:granodiorite:
monzo-diorite:quartz monzo diorite:quartz-monzonite:

Figure 3: A: Na_2O+K_2O diagram vs. SiO_2 (MIDDLEMOST, 1985);
B: characterization of intrusive rocks by using the parameters R_1-R_2 La Roche (1980).

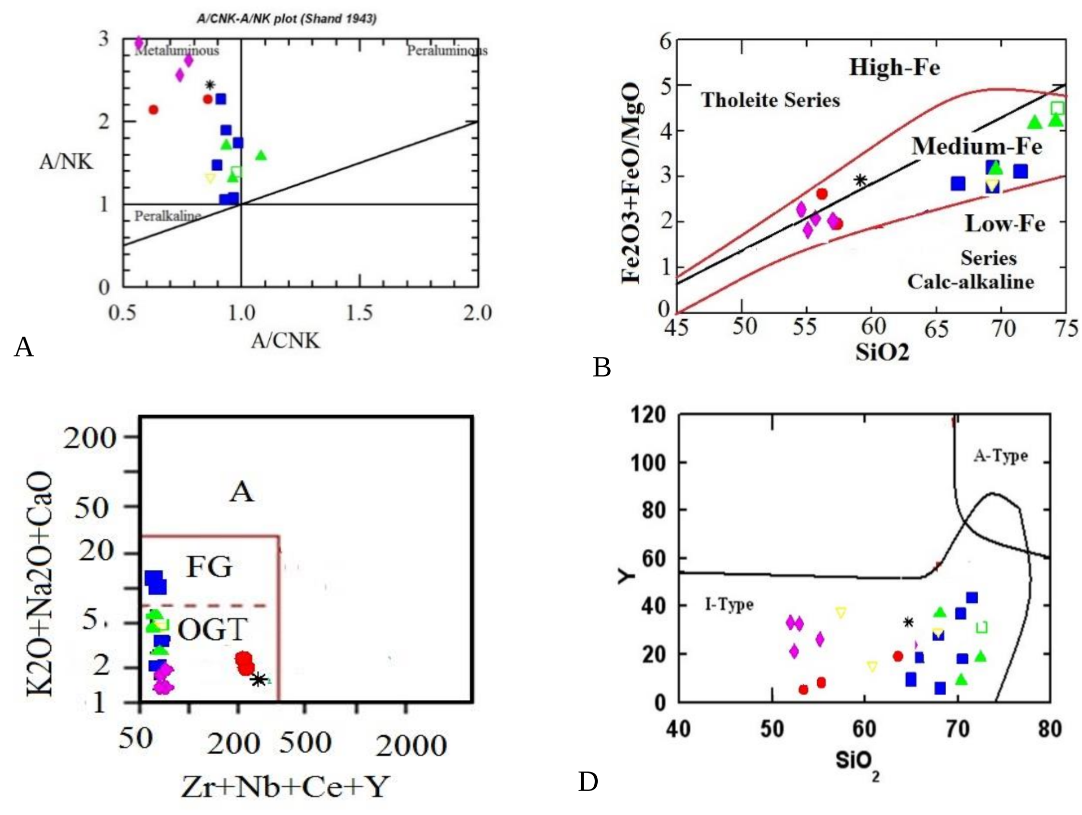


Figure 4: A: A/CNK-A/NK diagram (SHAND, 1943) to determine the degree of saturation of alumine igneous rocks in the studied area;
B: chart (MIYASHIRO, 1974) and placement of region samples in the position of the calc-alkaline series and high iron ranges, medium low (YING *et al.*, 2007);
C: chart $(Na_2O+K_2O)/CaO$ vs. Zr+Nb+Ce+Y (WHALEN *et al.*, 1987)
D: Y diagram vs. SiO_2 (FURNES *et al.*, 1996).

The rocks depleted in elements of Nb, Ba, Zr. Zr is an element that does not easily entire the main minerals, can be replaced by titanium subsidiary minerals (WILSON, 1989). The anomaly of this element is explained by the substitution of titanium phases such as titanite, titanomagnetite. Ba element can also be substitution for potassium in feldspar. Positive anomaly of other incompatible elements such as potassium and thorium are due to the abundance of these elements in the crust. Diorite samples show enrichment of Sr, Ba and K elements (Figure 2-4).

The enrichment of elements U, Th and Pb can be due to metasomatism or crustal deplation, and enrichment is less than Sr, K and Ba due to the absence or low frequency of Plagioclase calcium and feldspar in these rocks. The observed dispersion in Ba is due to the similarity of its geochemical characteristics with K and Ca. due to metasomatism in some of the studied stone, K followed by Ba has also increased. The depletion of the Nb element is probably due to the release of magma with crustal rocks. The average composition of the continental crust is strongly depleted from Nb. Therefore, each distributed magma with crust material shows the negative anomaly of Nb (SAUNDERS *et al.*, 1992; KENT, 1995; NAGUDI *et al.*, 2003).

Granite samples in the normalized spider diagrams show a lower enrichment of the Zr, Nb, Ti and Ba elements than the initial mantle (Figure 4-27). This feature the crust orogin. The negative anomalies of Ti and Nb, along with the enrichment of the elements U, Th, Pb and K, point to the importance of crustal rocks in the origin of magma (ALMEDIA *et al.*, 2007). Granitioid specimens are enriched from LREE and depleted from HREE, which represents the crust originating from the rock as a part.

Samples in tectonic environment diagrams Pearce *et al.* (1984) are located wothing the VAG range (Figure 6c and d). according to the graphs (MANIAR and PICOOLI, 1989), these rocks are in the range after orogeny and after collision.

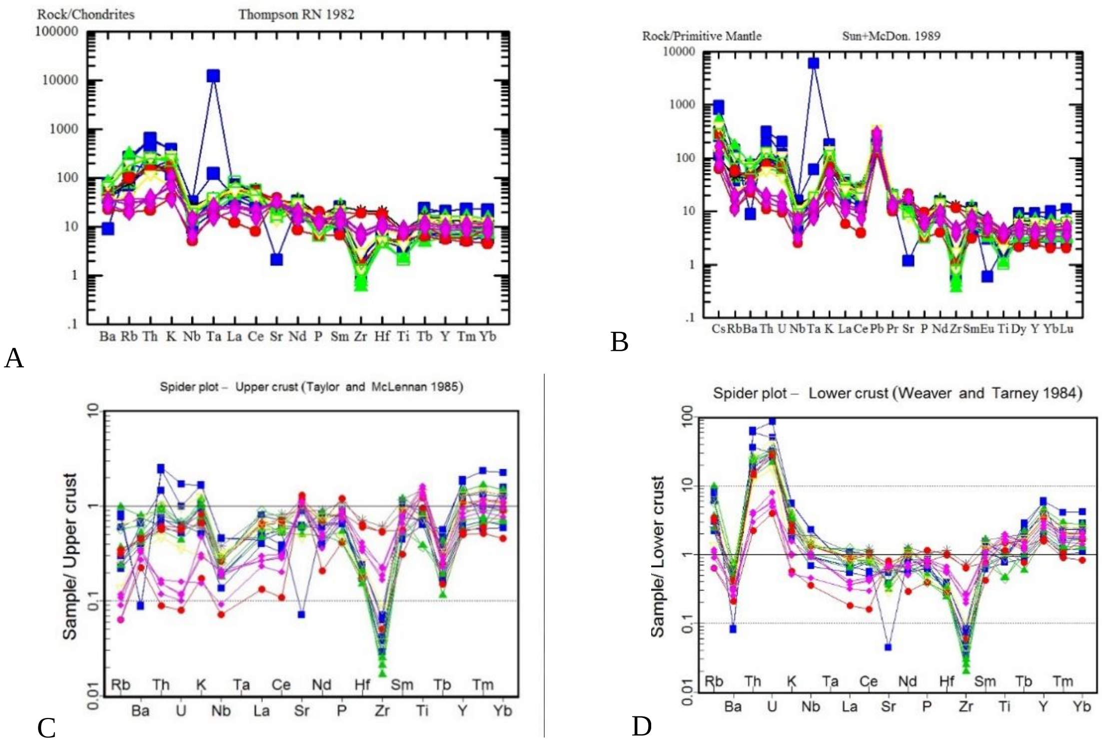


Figure 5: A: Anomalies spider diagrams of REEs relative to Kendrit (THOMPSON, 1982) for granite samples;
B: Normalized spider diagrams relative to the original mantle (SUN and McDONOUGH, 1989);
C: normalized spectral Scale relative to the Upper continental crust (TAYLOR and McLENNAN, 1995) for granite samples;
D: normalized spider diagram relative to the lower continental crust (WEAVER and TARNEY, 1984).

Samples in tectonic environment diagrams Pearce *et al.* (1984) are located wothing the VAG range (Figure 6C and D). according to the graphs (MANIAR and PICOOLI, 1989), these rocks are in the range after orogeny and after collision.

TECTONO-MAGMATIC PATTERN

Different patterns have been presented about the geomedical environment of Urmia-Doakhtar belt:

1- Some researchers believe in the in-continental rift pattern for magmatic belt (SABZEHRI, 1994; AMIDI, 1977; LESCUYER and RIOU, 1976; CAILLET *et al.*, 1978; EMAMI, 1981).

2- Some other researches of the subduction of the neotethysoceanic lithosphere below Iran consider it a reason for the occurrence of magmatism in this belt (TAKIN, 1972; KARIG, 1971; NOWROOZI, 1971; BERBERIAN, 1981; MOINE- VAZIRI, 1985; AFTABI and ATAPOUR, 2000).

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3- There are also comments that can be considered as a sort of aggregation between the two subduction and rift continental theories. For example, Nasiri (2006) believes that the subductionof neotethys under the central Iran, in addition to the production of sub-alkaline melting material (due to flux melting), has led to the induction of alkaline magmatic alkalinity (caused by decompression melting) (Figure 3-5).

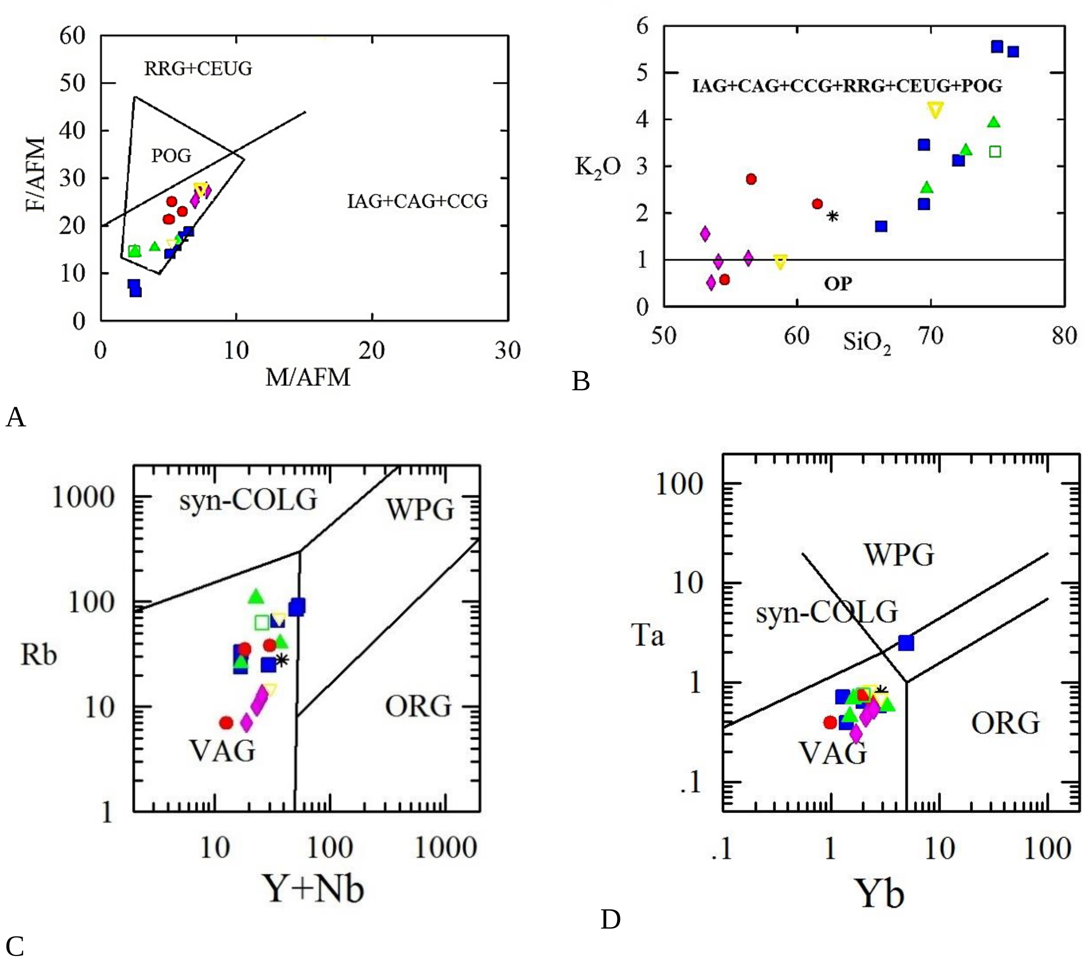

Figure 6: A and B: Distinctive charts of the tectonic environment (MANIAR and PICOOLI, 1989); C and D: diagrams by Pearce *et al.* (1984).

The petrological models presented for the origin of falsicmagmas in subduction zones are generally divided into two major groups. In the first model, flasicarchedmagmas from basaltic magma are produced by the separation crystallization or AFC processes (BACON and DRUIT, 1988; GROVE and DONNELLY-NOLAN, 1986).

In the second model, basaltic magmas provide the heat necessary for the melting of the lower crust stone (TEPPER *et al.*, 1993; GUFFANTI *et al.*, 1996; BULLEN *et al.*, 1990; ROBERTS and CELEMNS, 1993). It seems that the formation of Jebalbarez consist of both above models, and a series of crust and mantle models have contributed to the evolution of the Jebalbarez granitoid complex. In this way, with the occurrence of subduction and the arrival of fluids and the increase in temperature, the mantle wedge with varying degrees of melting has been formed and the mantle magma has been created.

Then, flowing the injection of a mantle mafic magma under the crust and as a result of the transfer of heat, fluids and molten into the crust, the melting process in the crust has been induced. At this stage, the proximity of the mantle mafic magmas and the crust magmas, to some extent, causes the mixing between these two magmas, and the resulting mixing these two magma to higher levels of the crust, and during crystallization and separation magmatic, a continuous spectrum of mafic rocks (in the gabbro limit) is up to falsic (from granite to alkaline granite), which mafic rocks have reached to surface of earth as volcanic processes and falsic from crust intrusive bodies (RASULI *et al.*, 2014).

Therefore, it seems that the magma subtraction in the magmatic room in the first stage leads to the formation of quartz- diorite to granodiorite composition, and in the second phase, with the continuation of magmatic subtraction, the magma composition is more acidified than before and the rocks with granodioriteto granite composition composed. In the third stage, with the continuation of the subtraction process, the composition of magma is highly acidic consists of granite and alkali granite stones.

CONCLUSION

Granitoidrocks east of Jiroft is in Urmia- dokhtar zone. Due to field features, mineralogy has a combination of diorite and synogranite and is geochemically located in the range of peraluminum and type I granite. In the tectonic environment, it is located within the volcanic arc (VAG) and formed by the subduction of neotethysunder the central Iran.

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