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Petrology and geochemistry of the post eocene felsic intrusives in ardestan area, Northeast of Isfahan, Iran

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Abstract

Felsic intrusions in the studied area are post Eocene and this region is located in the northeast of the Esfahan province. This area belongs to Uremia - daughter magmatic belt in Central Iran. Composition of Felsic intrusions are granodiorite and tonalite. The main minerals include: quartz, plagioclase, alkali feldspar and ferromagnesian minerals are amphibole are biotite. Most of ferromagnesian minerals alterated to chlorite and epidote. On the base of geochemical studies, granitoids are ranging from sub-alkaline, metaaluminous, magnesium series and I-type igneous rocks. These rocks enriched of LILE such as Rb, Ba, K, Ce and depletion of HFSE such as Y, Nb and Zr. REES chondrite normalized patterns indicate moderate to high enriched LREEs [(La/Yb)N= (1.27-18.22)] and a relatively depleted of HREEs [(Gd/Yb)N= (1/02-3/32)] with Eu Negative anomalies [Eu/Eu*= (9.55-9.57)]. Felsic magma are generated partial melting of crustal protoliths and mantle-derived basaltic magmas emplaced into the lower crust. These felsic intrusions rocks have mineralogical field and geochemical characteristics typical of volcanic arc granites related to an active continental margin. Probably, the Ardestan granitoids are the result of the subduction of neo- Tethyan oceanic plate below the Lut microcontinent and this oceanic residual plate during Mesozoic to Cenozoic time. Dehydration of subducted oceanic crust and partial melting of mantle wedge caused partial melting of subcontinental lithosphere, which resulted in the formation of metasomatized and enriched mafic arc magmas, and led to the formation of the Ardestan granitoid.

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Introduction

Geological map of the study area rectangle 1: 100,000 is Ardestan. In the region, in the north-east of Isfahan.The geographical range of lengths 30 ° 52، 52 ° and 30 °33 and 00 °33 northern latitudes. Tehran, Bandar Abbas, the main road connecting the area with the rest of the way. In order to achieve geological outcrop area can pave the way for the Eastern District Ardestan- Nain, Isfahan Ardestan- in Central, South and Ardestan- Zafargand- Zefreh in Natanz in the northern part of the region. Many of the roads are dirt roads branching makes possible the access to the entire area (Fig. 1).

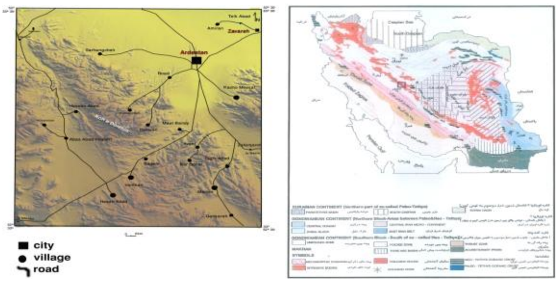

Fig. 1. A: Main roads to the area and B: Geographic location on the map in the area of structural division (Aghanabati, 2004).

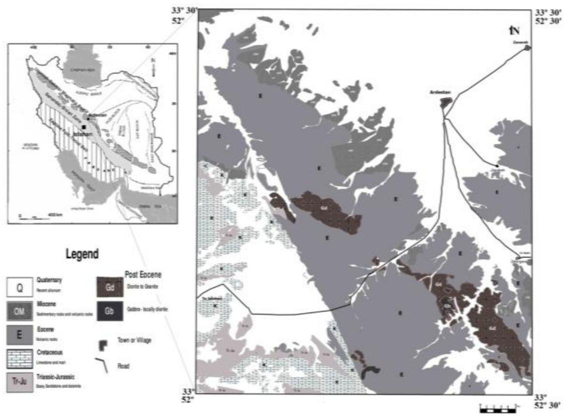

Fig. 2. Geological map of the study area (adapted from Radfar, 1997 with changes).

Granitic rocks or granitoids, i.e., granular igneous rocks that generally contain quartz and two feldspars,display great diversity because of the variety of their origins, sources, subsequent genesis and evolution processes, emplacement at different structural level sand under different tectonic regimes, in distinct geodynamic environments. About twenty petrogenetic classifications of granitoids are proposed in the literature. From their comparison, a synthetic classification was established (Barbarin, 1990). This classification is not widely used because of the complexity of the criteria, the absence of neat distinction between the types, the initials used to designate each type, and also because the links between granitoid types and geodynamic environments were not fully elaborated. In this re-port, granitoids are divided into fewer types, according firstly to field criteria such as mineralogical or petrographical parameters, then to chemical and isotopic criteria. The initials used to designate each type reflect both the typical AFM minerals and the chemical features. The origin and petrogenesis of each type are discussed in detail. To each geodynamic environmentis associated but a space-related or time related association of granitoid types rather than the most common granitoid type.

A few broad generalizations/conclusions:

1) Most granitoids of significant volume occur in areas where the continental crust has been thickened by orogeny, either continental arc subduction or collision of sialic masses. Many types of granite, however, may post date the thickening event by tens of millions of years.

2) Because the crust is solid in its normal state, some thermal disturbance is required to form granitoids.

3) Most workers are of the opinion that the majority of granitoids are derived by crustal anatexis, but that the mantle may also be involved. The mantle contribution may range from that of a source of heat for crustal anatexis, or it may be the source of material as well.

The purpose of this paper is to study mineral and petrology of granitoid masses and to the extentdeter mined by thetectono-magmatic setting. the formation and evolution of plutonic masses is possible.

Materials and methods

The area under study

The general trend in the granitoid intrusions Ardestan, NW-SE and generally follow the main trends in the area of the fracture. Many of these masses of sedimentary and volcanic rocks are cut by Eocene (Imam, 1981). So when magma injection should be given after the Eocene age 16-19 million years, this time also is consistent with geological evidence (Darvish Zadeh, 1370). Intrusive rocks in the direction of the pole basic composition (gabbro) to pole acid (granite) swing (Pilgrims, 2007). The extension to monzodiorite diorite intrusive rocks in the rock that is part of the mountains in the East Village Jvgnd Marbyn- Solomon Heights Dovarjin Abad village in the south and southwest of the fault Marbyn- Gnyan Rangan up area. mass monzodiorite about 50-52 square kilometers (Radfar, 1997). Also in the north and south of the village Avanjan Bideshk, Shahin Shahr and Meymeh village and part of the mountain Jougand, small and large masses of granitic rocks of granodiorite is seen that grainy texture to Micropegmatite graphics and the minerals quartz, alkali feldspar, plagioclase, biotite and amphibole (hornblende type) with secondary minerals apatite and titanite are formed. Enclaves in small and large masses of diorite in abundance in different parts of the region are sparse and moderately acidic (same source).

Ardestan In some areas, the granitoid masses of copper minerals malachite and azurite visible. By proceeding tectnomagma other porphiri copper mineralization zone of urmia - daughter magmatic belt metal mineralization associated with igneous rocks is very high.

Research Method

During field visits parts of unaltered granite, 135 rock samples were taken and then Thyh9 0 thin sections and study them with a microscope Polarizing, 53 samples using ICP-MS laboratory Acme Labs in Canada and 53 samples by XRF at the Institute of optimal test Sepahan Isfahan affiliate network technology research, major and minor elements were analyzed. (Analysis of relevant tables is provided.)

Result and discussion

Petrography

Composition of intrusive rocks Ardestan using modal analysis, granodiorite to tonalite to granodiorite. The main minerals include quartz, potassic feldspar, plagioclase, and amphibole types Biotite is ferromagnesian minerals. The most important tissue including granular texture, Puyiceletic and myrmectict. It is generally coarse-grained rocks in hand specimen and colorful coefficient proportional to the abundance of mafic minerals is variable. Quartz makes up about 20% modal mineralogical compositions that has a silent wave (Fig. 3 A), the most abundant plagioclase phenocrysts of quartz in the sections. Quartz is the most abundant phenocrysts of plagioclase levels. phenocrystals often shaped plagioclase and half is shaped. Some plagioclase with rounded margins is the result of the re-absorption is incomplete. Most plagioclase with synthetic poly twins and some of them making the region (Fig. 3 B) and more synthetic poly twins, they can be seen in Karlsbad. Almost all secondary minerals plagioclase analysis is to experience high levels of plagioclase ·hay has seen. Less alkaline feldspar samples, and are often grown kaolinized and some of the surrounding quartz (Fig. 3 C). The amphibole rocks outcrop in the area is higher than the other. Amphibole are primary colored olive green to pale green Shvd. Biotite seen as Aidomorph with multi-colored brown to green can be seen in the breakdown of biotite and chlorite (Fig. 3 D). Accessory minerals include apatite, chlorite, epidote minerals Apak (Fig. 3 E, F).

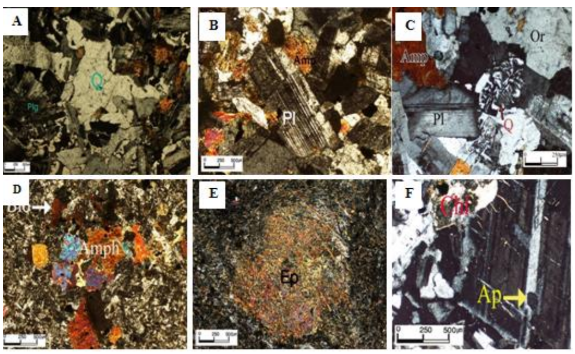

Fig. 3. A: Quartz crystals and minerals, plagioclase, B: Plagioclase twins shaped poly-synthetic and zoning, C: Myrmectict tissue (Hmrshdy mineral quartz and feldspar), D: Biotite and amphibole analysis of chlorite, E: mineral epidote the resulting breakdown of plagioclase, F: Apatite minerals as inclusions in plagioclase and chlorite.

Geochemistry

Geochemical classification

Average amount of SiO2, Al2O3, MgO, CaO, Na2O, K2O, K2O / Na2O, A / CNK and Mg # equal to 61/65, 15/35, 4/96, 6/83, 3/94, 2/16 0/78, 0/63 and 42/75 wt%, respectively. Plutonic rocks were named in addition to the medal, diorite and quartz diorite is based on the chemical composition diagram (Fig. 4 A), the intrusion of the nature of the sub-alkaline, alkaline and calcic significant (Fig. 4 B, C, D), usually granitoides alkaline magma mixing can be achieved (Berberian, 1999).

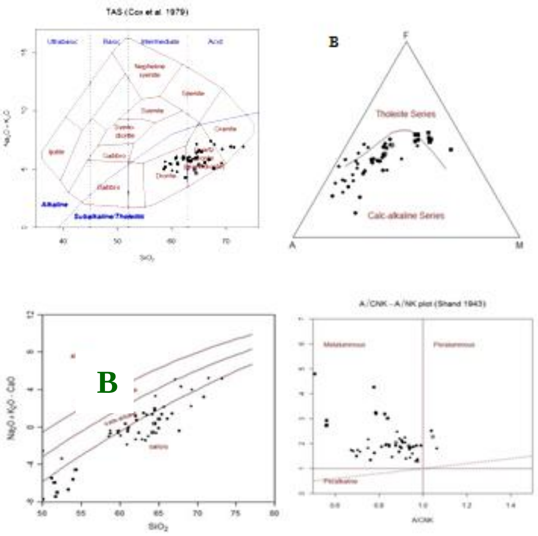

Fig. 4. A: Classification of igneous rocks based on the total levels of silica (Cox *et al.* 1979), B: Triangular diagram FeOt-Na2O + K2O-MgO (AFM) (Irvine and Baragar, 1971), C: Chart Na2O + K2O-CaO to SiO2 (Frost *et al.*, 2001) and D: Chart a / CNK against a/NK (Shand, 1943).

All of the area in the diagram (Fig. 5 A) is in the range of magnesium. Using the weight of the core elements of K2O and Na2O granite type I of granite and S-type can be distinguished (Wallen, 1987), the plot of samples within the granite type I located (Fig5 B), the results of studies experimental and Klymnz Roberts (1993) suggests that it may cause moderate to high potassium calc-alkaline I-type granitoid area, or to change its basic lower crustal amphibolite (Fig. 5 C, D).

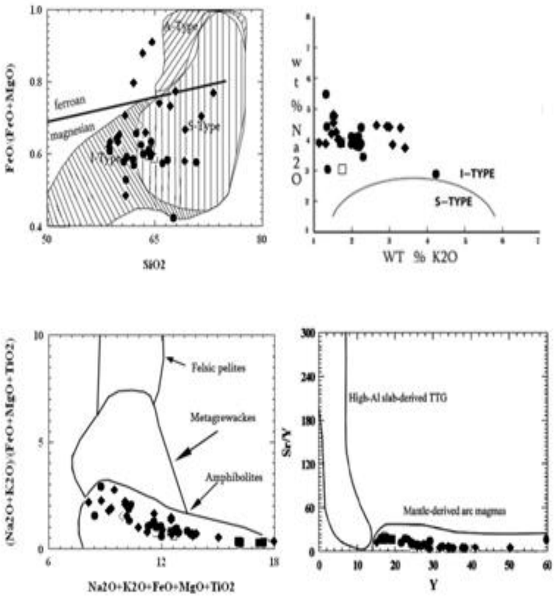

Fig. 5. A: Diagram FeO/(FeO + MgO) versus SiO2 (Frost *et al.*, 2001), B: Chart Na2O versus K2O (Wallen, 1987), C: Chart (Na2O + K2O)/(FeO + MgO + TiO2) vs. Na2O + K2O + FeO + MgO + TiO2 (Patino, 1993) and D: chart Sr / Y versus Y (Thomson, 1996). As seen in the above examples are Ardestan in the melting of amphibolite.

Geochemistry of trace elements

For REES patterns are normalized to chondrite diagram used (Taylor and McLennan, 1985), the diagram (Fig. 6 A), indicating a trend of almost uniform, flat and generally not achievable pattern in the distribution of supplies HREES the [(Gd/Yb)N=(1/02-3/32)], is, while LREES enriched and subtraction survivor of the show [(La/Yb)N=(1.27-18.22)]. This indicates the differentiation of these elements, Eu negative anomaly shows [Eu/Eu*=(9.95-55.75)]. Separation of feldspar from felsic lava rise is negative Eu anomalies (Taylor and McLennan, 1985). In (Fig. 6 B) Changes in trace elements relative to their frequency in the chondrite normalized by (Taylor and McLennan, 1985) and negative anomalies and certain of Rb, Ni, Sr, Zr and P, as well as anomalies positive Tb, La, Ba, Ce show particular that of alkaline granitoid is robust and can melt or partial melting of the lower continental crust and mantle wedge is compatible with low temperature. LREES element enrichment and depletion of HFSE reveal volcanic arc magmatism metaluminous type I (VAG) is. Paradigm (1999) suggest that the frequency of LREES enrichment may be due to partial melting or origin of these rocks are relatively rich in alkaline elements associated with subduction zones (the paradigm *et al.* 1999). (Fig. 6 C, D).

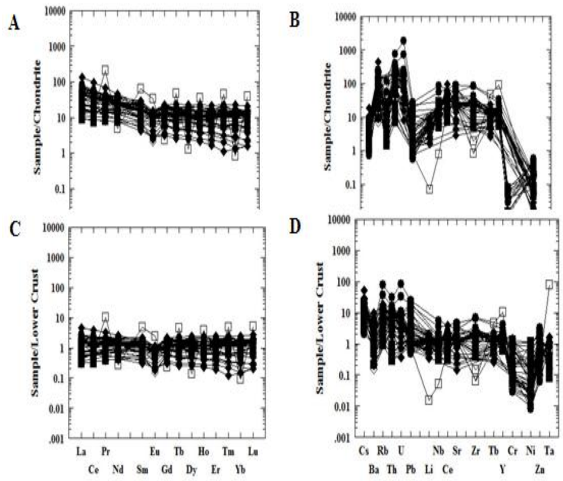

Fig. 6. A: The values of the chondrite normalized rare earth elements rocks, B: Values normalized to chondrite rocks of several elements, C: Normalized amounts of rare earth elements in rocks of the lower crust and D: Samples several elements of the crust rocks down on the spider diagram (Taylor and McLennan, 1985).

Tecnomagnetic setting

Batchelor, and Bowden (1985) on the basis of changes in the R1-R2 diagram to separate the tectonic granitoid presented. Separation of tectonic environment by Pierce *et al* (1983) proposed a range of volcanic arc granites (VAG) is placed (Fig. B-7). The charts provided by Schandl and Gorton (2002) samples in the active continental margin (ACM) and oceanic arc (Oceanic arcs) are (Fig. 7 C, D).

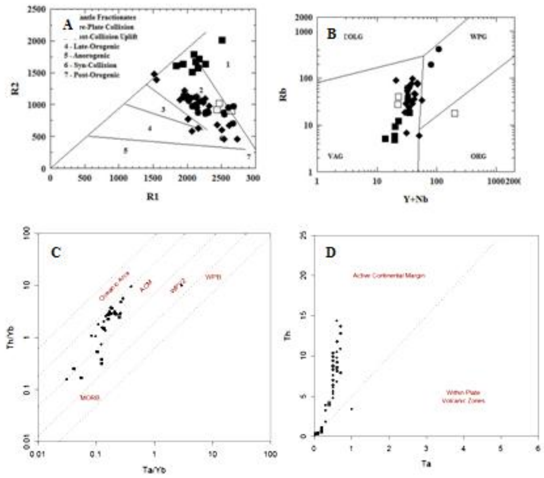

Fig. 7. R1- R2 (Batchelor and Bowden, 1985), B: Graph partitioning the tectonic granitoids (Pierce *et al.,* 1984), C and D: Tectonic diagrams (Schandl and Gorton, 2002).

Conclusion

The model of the origin of the formation of magmas felsic in the volcanic arc consists of two groups: a) the AFC and b) partial melting is of the lower crust of the heat of mafic magma or mantle. In the study area due to the huge mass of granitoid, a high amount of SiO2 in it, and older intrusions of gabbro with the small size of the region, the enrichment of incompatible elements such as Th, Rb, Li compatible with the first or forming processes AFC is not. Due to the high similarity of the distribution of REE and incompatible lower crust acceptance second model is more acceptable to the intrusion. Based on the findings of this study can be a source of magma or equivalent Tamtatvnalyt metabasalts amphibolite metamorphism it is the composition of the lower crust is similar Civet. Based on petrographic studies and geochemistry of granitoids can protolith melting of the lower crust is made up of the upper crust contamination has been found. Mafic enclaves in the case of deeper origin of basaltic magma is emplaced in the lower crust and probably heat for melting of the lower crust has made, Mixing basaltic magma and by the magma of the original magma intermediate product felsic dioritic it has created. Processes actually continue after the magma ocean Saudi Plates thrust under the Lut block the formation of intrusive erea been studied. These studies are consistent with the results Pourhosseini (1981), which suggests a simple model for the AFC is not intrusive, but around town Ardestan artist Studies and Hashk and colleagues were consistent and confirmed and show high similarity with Brgvhr intrusive felsic intrusive complex is Ardestan around town. Zagros zone between the Eurasian and Arabian plate, resulting in the disappearance of ocean oceanic created, Collision time is very controversial and the Upper Cretaceous, the Miocene or the early Pliocene in the literature mentioned, however most support Eocene to Oligocene. The evolution of the Zagros Orogenic in the middle to upper Cretaceous period includes the time specified by disorganization and confusion plate below processes and mechanical coupling of the page, the Paleocene-Eocene arc Magmatism Kennedy and development of tension in the upper crust and then expand the Oligocene collision belt and the formation of urmia - daughter is present. Based on the geochemical evidence for the origin of mafic magma intrusions of magma derived from the mantle and crustal melting. During the process of subduction magmatism during or after stretching phases simultaneously applied to continental collision happened.

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