# The Petrology and Petrogenesis of Tertiary Volcanic Rocks of Jasb Area

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## Abstract

*The Jasb area is located about 230 Km. South of Tehran (10 Km of the N-NE of Delijan) in Urmiyeh-Dokhtar magmatic belt. The scattered volcanic rocks belong to Eocene, Miocene and Pliocene, and they can be classified into two groups: intermediate to basic lava flow and pyroclastic rocks. The volcanic rocks' type variations are rhyodacite, dacite–andesite, andesite and basaltic andesite. The petrographic studies revealed that the textures of volcanic rocks are mainly porphyritic.The andesite rocks belong to Eocene and Miocene and these rocks are located in the middle of the area that was investigated in this study. Some kinds of this lava are riched in $Al_2O_3$, Sr. and Ba. The subvolcanic-Volcanic domes of Pliocene that locally cut the upper red formation (Miocene) deposits. The petrographic study shows that they are rhyodacite and that there are euhedral phenocrysts of plagioclase and amphibole in these kinds of rocks. The high viscosity magma had formed the rhyodacite domes. The magmatic series of volcanic rocks except basaltic andesite types that are toleitic are calk alkaline. The change in abundance of minerals such as pyroxene, magnetite, amphibole, biotite, plagioclase and feldspar in the volcanic rocks, indicates the successive process of differentiation in intermediate magma; the same change created variation in lithology. Pyroclastic rocks belong to Eocene and have acidic composition (i.e., dacite lithic- crystal tuff); they were formed by explosive volcanic eruptions and were deposited in shallow sea environment. The pattern of Rb/Yb+Nb diagram of the volcanic rocks in the study area shows the similarities with magmatism of Volcanic Arc regions. Based on the analyses results, the geochemical diagrams were drawn and interpreted. Defining the lithology of volcanics, the tectonomagmatic setting condition, magmatic series, and geochemical variations are the results of geochemical and petrological studies of volcanics in the area.*

**Keyword:** *Petrography, Geochemistry, Volcanic rocks, Jasb, Tectonomagmatic setting, Calk alkaline magmatic series*

## 1. Introduction

The Jasb area is located in the end part of East part of Markazi province, about 230 Km.South of Tehran (fig1). This paper describes petrography, geochemistry and evolution of different types of volcanic rocks.

## 2. Geological setting

Jasb extrusive bodies are located in the region of the N-Ne of Delijan in central part of Iran (fig. 2). The first major events in the Tertiary volcanic history in area include the eruption of various basic to intermediate flows, tuffs, and volcanic breccias. The volcanic rocks consist of several separate outcrops with an elongate northwest-southeast trend relatively. All of these volcanics (ranging from basaltic andesite through to ryhodacite) lie within the Urmiyeh-Dokhtar magmatic belt as a part (subzone)of Iran-E-Markazi zone. Emami (1981) , Schroder

(1994) and Ghalamghash (1996) studied the stratigraphy, petrology and structural geology of the region. The Jasb area is in the geological quadrangle map of Kahak at a scale of 1:100000 on 1998 by Ghalmghash.J and Emami.M.H (fig2). The extrusive rocks in the area are belonging to Eocene, Miocene and Pliocene. There are some ryhodaciteic dome structures in Honda Mountain and around of Ravanj village. There are subvolcanic – volcanic dome which replaced in Neogene deposits and cut the Miocene sedimentary rocks obviously. The form of magmatic structures, depth of replacement, deformation of around rocks is influenced by magma and specially differentiation of viscosity of these kinds of rocks with other kinds of rocks in this region (Emami1981). The outcrop of andisite and dacite are the middle and the north of the investigated area which have seen with tuff and volcanic brecia. Pyroclastic rocks mainly lie in middle and east part of this area.

## 3 –Petrography

Crystals in volcanic rocks give clues to processes and time scales of magma evolution ( Bacon &Loewenstern 2005).The scattered volcanic rocks belong to Eocene, Miocene and Pliocene, and they can be classified into two groups: intermediate to basic lava flow and Pyroclastic rocks. The volcanic rocks' type variations are rhyodacite, dacite–andesite, andesite and basaltic andesite.The ryhodacite rocks ($Pl^{r}$) are subvolcanic –volcanic domes that were formed in western part of investigated region. The color of ryhodacite in hand samples in new broken part is green. The ryhodacite minerals are composed of low-medium grained plagioclase, quartz, amphibole and alkalifeldespar (fig.3.a). The composition of the plagioclase in this rock is oligoclase- andesine and that of amphibole is hornblend, which has been altered to chlorite in some samples. The amount of alkalifeldespar is less than other minerals. The outcrop of dacite-andesite ($M^{tv}$) is NW in the investigated area. The color of its in fresh parts is grey-brown. These samples show porphyritic texture. The primitive minerals of these kinds of rocks are plagioclase, alkalifeldespare, amphibole (hornblende) and pyroxene (rare). The composition of plagioclase is albite-oligoclase and in some cases andesine. Pyroxene mineral (hypersthene and some cases ugite) altered to serpentine and chlorite.

The volcanic rocks undertook the hydrothermal alteration during the waning stages of the explosive activity and include secondary minerals such as albite, chlorite, calcite, epidote, hematite, and quartz. The change in abundance of minerals such as pyroxene, magnetite, amphibole, biotite, plagioclase and feldspar in the volcanic rocks, indicates the successive process of differentiation in intermediate magma; the same change created variation in lithology. Pyroclastic rocks belong to Eocene and have acidic composition (i.e., dacite lithic- crystal tuff); they were formed by explosive volcanic eruptions and were deposited in shallow sea environment.

### 4. Analytical method and results

For this research about 95 volcanic rocks samples were collected. Having completed petrographical studies, x-ray fluorescence spectroscopy (XRF) was used to analyze 19 volcanic rock samples for major elements and the selected trace elements. The determination were carried out on a Phillips PW 1480 and 1400 x-ray spectrometer fitted with radium ( Rh) tube at Kansaran Binaloud and at Ministry of Geological Survey of Iran. Results of the major and analyzed trace elements are listed in table 1.

## 5. Geochemistry

The intermediate and relatively basic rocks probably formed as lava flows in the different volcanic processes. The intermediate rocks of the area exhibit a wide range of silica SiO2 content (55to70 wt. %). Mg is highly depleted in most samples. According to Na2O+K2O/SiO2 diagrams (Lebas et al 1986), a majority of the volcanic rocks in the area fall in the andesite district. Major-element Harker (1909) variation diagrams reveal the expected linear variation for a group of co-genetic lavas. MgO and CaO correlate negatively with $SiO_2$ (fig.5) and the trends are smoothly decreasing. Consistent with petrographic observations, it is likely that the trends indicate the fractionation of clinopyroxene, and Ca-rich plagioclase. $Na_2O$ and $K_2O$ correlate positively with $SiO_2$ concentration (fig.5), while $P_2O_5$ shows initial enrichment and then depletion at ~50 wt% $SiO_2$ (fig5). The depletion of $P_2O_5$ is probably indicative of apatite crystallization. Similarly, after initial enrichment, $TiO_2$ and $Fe_2O_3$ concentrations simultaneously decrease, indicating the crystallization of Ti-bearing clinopyroxene and Fe-Ti oxides.

Trace element data provide additional petrogenetic information. The volcanic rocks samples contain relatively low concentration of the HFS elements, and some degrees of concentration in the LFS (Sr, Br, and Rb).Some trace elements such as Sr, Rb and Ba are concentrated in the silicate phase rather than in accessory minerals. Therefore, Sr, Ba and Rb have positive trends (fig.5). These elements can enter biotite and alkali feldspar (Wilson1989). According to ($Na_2O+K_2O$) /$SiO_2$ and FAM diagrams (Irvine & Baragar 1971), all of the samples in the area fall in the sub alkaline and calk- alkaline type except basaltic andesite samples (fig.6).

## 6. Tectonic setting of volcanic rocks

The samples which studied in this paper provided a window into different processes in volcanic rocks. The Bidhand major fault with N-S trend was influenced on volcanic rock's magma uplifting. The magmatic settings can classified on chemical method (Pearce1976).The pattern of Rb/Y+Nb(Pearce et al 1984) diagram of the volcanic rocks in the study area shows the similarities with magmatism of Volcanic Arc regions (fig.7).The calk-alkali magma is for completely mature and the board of active continental (Rollinson1992).Based on diagram of ANK/ANCK the compositions of volcanic rocks show meta aluminous nature(Maniar &Piccoli 1989);therefore, the volcanic rocks of area are related to orogenic setting.

## 7. Conclusion

The scattered volcanic rocks belong to Eocene, Miocene and Pliocene, and they can be classified into two groups: intermediate to basic lava flow and pyroclastic rocks. The volcanic rocks' type variations are rhyodacite, dacite–andesite, andesite and basaltic andesite. The pyroclastic rocks are tuff and ignimbrite. The high viscosity magma had formed the rhyodacite domes. The magmatic series of volcanic rocks except basaltic andesite types that are toleitic are calk alkaline. The volcanic rocks in the study area show the similarities with magmatism of Volcanic Arc regions. Based on diagram of ANK/ANCK the compositions of volcanic rocks show meta aluminous nature; therefore, the volcanic rocks of the area are related to orogenic setting.

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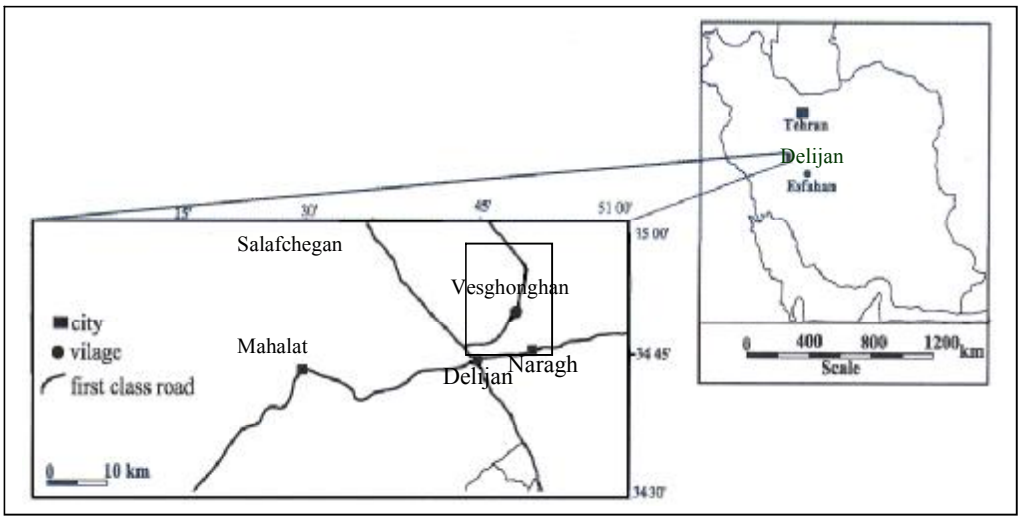


**Fig.1. Simplified geographical map of the area ( the investigated area is shown in the frame)**

**LEGEND**

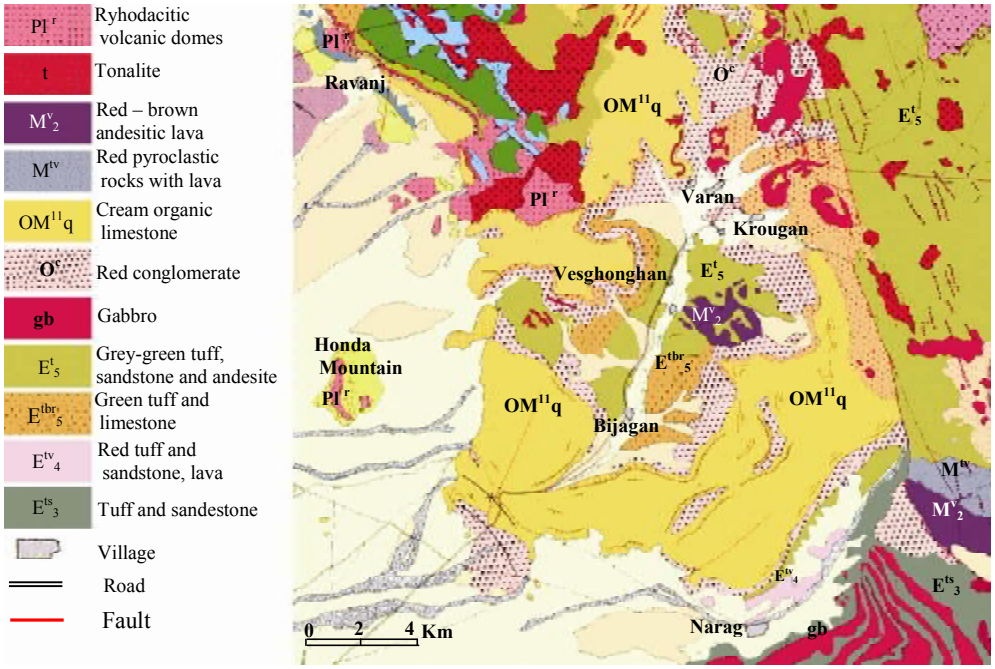


**Fig.2. The geological map of Jasb area; showing the geological setting and lithological units of the Jasb volcanic suite as a part of geological map of Kahak sheet No.6158 (GSI-scale: 1:100000)**

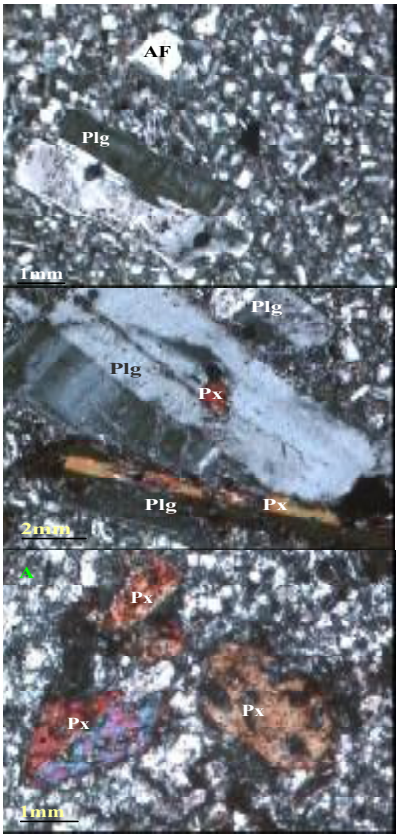


**Fig.3.The microscopic images of the texture of studied samples,(XPL):**
**a: ryhodacite, image showing alkali feldespare (Af) and plagioclase(Plg) in matrix**
**b: andesite,an image of zoned plagioclase (Plg) and clinopyroxene(Px) in matrix of plagioclase and alkali feldespare**
**c: basaltic andesite, image showing pyroxene in matrix**

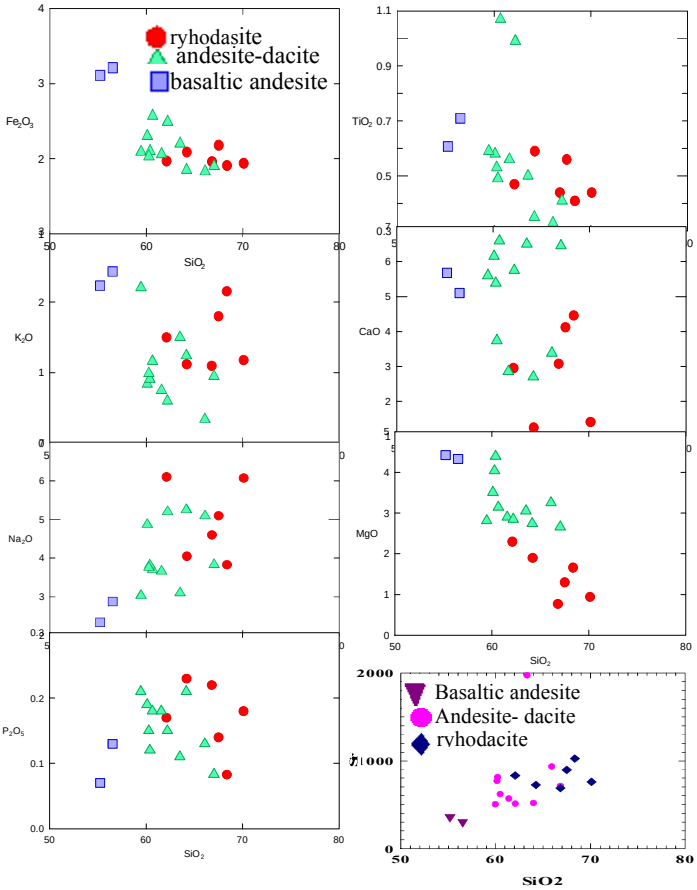


**Fig.5. Variation of major and trace elements vs.$SiO_2$**

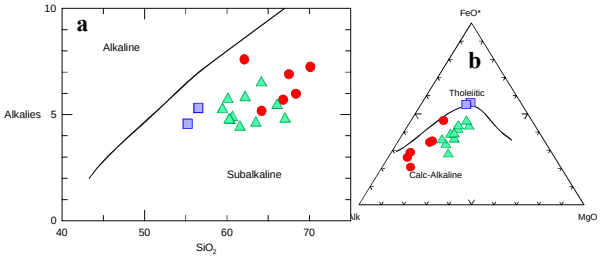


**Fig.6. Volcanic samples in two diagrams:**
**a: $Na_2O$+K2O- SiO2 and b: AFM(Irvine & Baragar1971),**
**- sings are like fig.5**

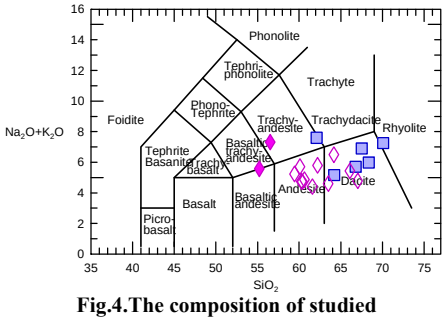


**Fig.4.The composition of studied samples, Alkali-$SiO_2$ ( Lebas et al 1986)**

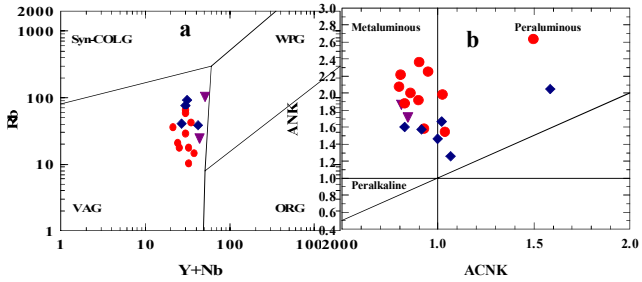


**Fig.7. The composition of studied samples plotted on two diagrams: district. Sings are like fig.5**
**a: the tectonic discrimination diagram of Pearce et al ( 1984) ;**
**b :diagram of ANK-ACNK(Maniar &Piccoli 1989), the most samples plotted on meta aluminous**