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Petrography and petrology granitoid Rocks of Nokeh, NE of Semnan

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ABSTRACT

The studied area is located in the 10-12 Km of the N-NE of Semnan in the end of central Alborz structural zone. Sedimentary, Igneous and metamorphic rocks are the main rocks us this area. Igneous outcrops include granitoids. Nokeh granitoides contain mainly granodiorite and alkali feldspar granite. Quartz, plagioclase and k-feldspar are essential rock forming minerals of the granites. Granitic rocks show the granular, graphic, Myrmekite and perthite textures. With attention to field, petrography and geochemistry investigation, the granitic rocks originated from melting of lower crustal igneous rocks. Granites rocks have metaluminous to weak peraluminous nature and belong to I-type granitioids of continental volcanic arcs. Metasomatism process along the contact of granitoid rocks with host rocks is resulted to form iron skarn. Skarnization (in general concept) and producing garnet-megnetite-diposide paragenesis and scapolitization in the alkali-feldspar granites and their tuffaceous host rocks. Contact metamorphism progressed to pyroxene hornfels facies and maximum P-T condition is: 500-600 º C temperatures and about 2 Kbar.

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INTRODUCTION

12 km north of the study area - North East Semnan in lengths up to '30 º 53 '30 º 52 East longitude and latitudes '43 º 53 '39 º 35 North is up. Classification of structural units in the study area is located in the East Central Alborz zone (Figure 1). The composition of these rocks stone, geology, chemistry, magmatic and tectonic setting of the series, particularly in relation to the occurrence of Cenozoic tectono-magmatic central Alborz is of particular importance.

Discussion:

Stone statues of the three categories: igneous, metamorphic and sedimentary rocks are divided. The Cretaceous and Cenozoic times, mostly belong body. Of sediments and sedimentary sandstone sculptures Quaternary alluvial sediments of Cretaceous conglomerate and body of igneous rocks and volcanic- sedimentary Eocene intrusive mass and they are the Middle Eocene. Volcanic rocks composed predominantly of basalt, andesite and Trachyandesite are combined with rocks Pyroclastic basic, intermediate and acidic alternatively be seen in the southern village Nokhe. Fragments of volcanic and pyroclastic rocks of different sizes as enclaves are found in Nokhe North Granodiorite. Olivine gabbro and diorite intrusions by combining an erratic pass gazelles in the surrounding villages, E. Abad, Ali Abad Chashtkhoran sides of the road-Semnan and Damghan within pyroclastic Eocene volcanic outcrop. Although the effect of the thermal mass of the host rocks are. However, due to the type of host rock composition (basic and intermediate volcanic rocks of Eocene), basic and lacks fluidity and lack of contact metamorphism are shallow lump. Alkali feldspar granite intrusive masses acid composition, monzogranite and granodiorite stock in the surrounding villages in northern Semnan appear Nokeh and inject them in the Eocene volcanoclastic sequence taken.

Associated with this mass region are metamorphic rocks and metamorphic minerals of any enclaves or not. But because of succulent nature of their influence in Cretaceous limestone and calcareous tuffs and Vulcan stupid and Eocene, contact metamorphism of calcic iron skarn host rocks have created. Skarn zone, mineralization of iron and diopside - garnet - magnetite skarn limes and alkali feldspar granites and tuffs are composed of skapolite. Pyroxene hornfels facies Petrographic studies show the change in temperature from 500 to 600 ° C and pressure is less than 2 kbar. In this area there are many major and minor faults. The major faultes

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are fault Semnan, Nokeh and Diktash noted. These faults are likely to play a major role in the formation of igneous rocks and ore generations substituting in the region have.

Fig. 1: Map of study area and location of structural-sedimentary units (Aghanabati, 1383).

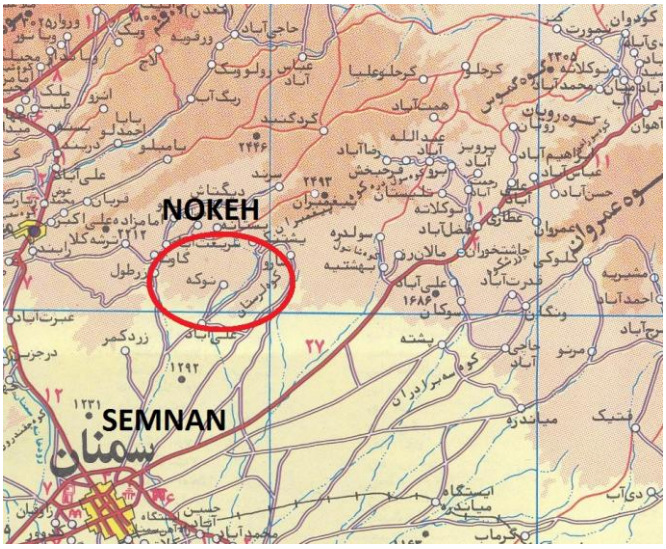

Fig. 2: Map of access roads to the area Nokeh - Chashtkhoran – Semnan (Scale: 1:300000).

Outcrops in the East Village and the development of granodiorites Nokeh than are other types enjoy. The original size of these is intrusive into account. Greenish gray in hand specimen and one of the prominent characteristics of these rocks occur presence premature parts of the body they-are. These enclaves of predominantly fine-grained biotite and hornblende, and they seemed more than why are dark. Mafic microgranular enclaves or with different sizes are found in these rocks. Monzogranite and alkali feldspar granites of the less developed and more rural areas of the West and Southwest Nokeh outcrop.

Monzogranite samples are hand white to light cream, see. Epidote and chlorite alteration has affected the rocks and formation is clearly seen in them. However, some sections of chlorite information so that the stone is of a dark color. Alkali feldspar coarse alkali granite with more than There is reason to be pink. These rocks have been affected by alteration. Alavi (1366) has introduced granitoid Nokhe entitle Adamelit.

Petrography:

A – granodiorite: Subhdral , microscopic granular texture (grain form a significant part) but tissues can be observed graphically and Mirmekite. Major minerals in these rocks are plagioclase, quartz, and small

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amounts of potassium feldspar and biotite, green hornblende, augite, sphene and opaque minerals, rocks and other minerals are constructive. Minerals chlorite, epidote, calcite and sericite as secondary minerals are. The compositional zoning of plagioclases have been considerably altered to sericite have. There is an abundant sericite crystal in the center because it is the composition of calcic plagioclase from the periphery to the center is more. The potassium reacts with the manufacturer anorthite plagioclase, anorthite in plagioclase-rich area of part and A can be easily sericite (Sheli, 1994). Compositional zoning in these crystals also exhibit differences in their surrounding environment (Holten, 2000). A titanite crystal in many sections of the primary and the secondary is. Possible presence of sphene secondary alteration of augite, biotite or Tytanomgnetite is the link. Primary titanite crystals are often the result of magma crystallization and having dimensions of 0.5 to 1 mm and a half and wedge shaped regions, but mainly small-scale secondary titanite crystals there are amorphous. Sphene secondary reaction with CaO TiO2 released from damaged plagioclase and silica are present in the environment. Silica can be part of the process; chlorite and plagioclase rest during the degradation process can be obtained.

B – Quartz these rocks have a granular texture, are myrmekite and granophyric. They frequently minerals, quartz, K-feldspar, plagioclase and clinopyroxene form of to. Their main minerals include titanite, apatite and opaque minerals are. Most hydrothermal alteration of plagioclase to sericite, calcite and epidote are decomposed. Some plagioclase and quartz as the growth (myrmekite tissue) have been developed.

C – Alkali feldspar granites subhdral, microscopic granular texture (grain form a significant part) but tissues can be observed graphically and perthite. Major minerals in these rocks include K-feldspar, quartz and small amounts of plagioclase are biotite, amphibole, titanite and opaque minerals are other rock formations. Minerals chlorite, epidote and sericite as secondary minerals are. Almost all crystals alkali feldspar has sustained alteration of clay. They can be because analysis of hydrothermal solutions and medium grain texture mention that they are prone to breakdown and alteration.

Fig. 3: Prospects of the masses in the West Village monzograniteand Nokeh (view towards the East)

Fig. 4: View of the West Village Granodiorite Nokeh

Geochemistry:

Sample elective from the masses intrusive in the diagram classification of chemical Streckeisen (1979), in the range of and quartz monzonite, granodiorite, alkali feldspar granite (Figure7A) and and Index Peacock (Pksrilov and Taylor, 1976) divided by the sum of the wt% CaO wt% Na2O + K2O is defined as (Bogarts *et al*, 2003) According to this chart, most examples - case studies within the calcalkaline are located (Figure7B). Trends in silica and oxides of major and trace element fractionation index showed high values of Na2O, K2O, Zr, Ba, Hf, and low amounts of acidic rocks AL2O3, CaO, FeO, Fe2O3, MgO in them. To investigate the changes of trace elements and rare-earth spider diagrams (Tami and Weaver, 1984; Boiton, 1984) is used. As seen in Figure 10, the pattern of trace elements and rare-earth samples studied parallel process and results are almost identical. According to Wilson (1989), if a set of processes bearing rocks of fractional crystallization are associated with each other, resulting in the amounts of trace elements and their ratios constant and continuous to change the. In light of all these diagrams, Rare earth elements (LREE) relative to heavy rare-earth elements

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(HREE) enrichment more to show. The high point of the relative amounts of trace elements and rare-earth acidic and basic, which is near to the sample

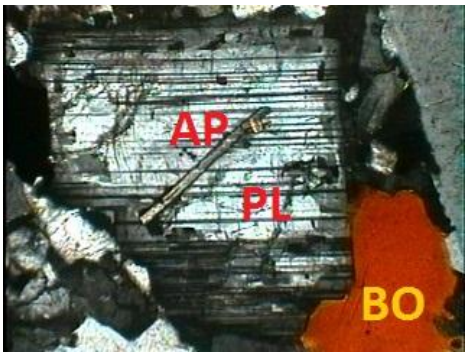

Fig. 5: Image of microscopic indicating the presence apatite rock granites (XPL) enlarge http 100 against.

Fig. 6: Image of microscopic represents zoning in Plagioclase existing in Granitic Rocks (XPL) enlarge http 100 against.

According to figures Furness *et al* (1996) and Coleman *et al* (1986), samples of granitoid will be in the region of type I (Fig. 11). Tectonic discrimination diagrams of Pearce and colleagues in this instance (1984) and Harris *et al* (1986) are located within the VAG (Figure12). The graphs were plotted to determine the environmental teknomagmaie granitoid rocks of this region as can be in the range of volcanic arc rocks are composed .To realize the mechanism of formation and tectonic setting of igneous rocks, the study of important events took place during the Cenozoic is. One of the most important events in the Cenozoic, Neotetis oceanic subduction beneath the central Iranian block and the collision between the Arabian plate and Central Iran is - is. This is the result of subduction and collision 3 to form volcanic belt (Central Iran, Lut, and Alborz) and received numerous intrusive masses pointed. From other hand due to presence basaltic magma Temperatures in continental crust a gone up and lead to of partial melting Rocks in crust, a has been. For felsic magmas in arc and back-arc environment, there are two modes:

1- Differentiation of a basaltic magma during digestion and fractional crystallization (AFC) (Nolan Gage and Donnelly, 1986; Bacon and Droit, 1988). Hildrs and Morbas (1988) has described this model as Model MASH have (M: Melting, A: Assimilation, S: Storage, H: Homogenization).

2 - Partial melting of crustal rocks (Bullen and Clinne, 1990; Roberts and Clemens, 1993; Tepper *et al*., 1993; Guffanti *et al*., 1996). Rocks derived from partial melting of crustal rocks a high frequency elements Rb, Th, U, K, La (LREE), and are Pb elements of Ti, Ta and Nb are relatively ineffective indicates contraction. The rocks are weakly differentiated, rich and poor animation HREE elements they will seen.

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Table 1: Results of geochemical analysis of major elements and trace minerals Manufacturer examples granitoids Nokeh area.

Oxides (wt %)	SiO2	Al2O3	Feo	MnO	MgO	CaO	Na2O	K2O	TiO2	P2O5	Total
S-1-3	61.81	20.9	2.25	0.04	1.9	4.87	3.69	3.64	0.61	0.11	99.81
S-1-4	63.7	18.67	3.23	0.05	1.86	3.93	3.39	4.14	0.61	0.13	99.7
S-4-2	61.28	23.23	3	0.04	1.39	2.71	3.14	4.3	0.54	0.1	99.72
S-4-3	61.23	23.56	1.21	0.02	1.67	3.48	3.7	4.32	0.57	0.14	99.9
S-3-4	56.78	28.44	2.64	0.03	1.33	3.15	2.78	4	0.5	0.11	99.77
S-3-1	71.63	18.79	0.21	0.12	0.07	0.51	3.7	4.85	0.17	0.06	100.14
S-3-3	65.34	18.35	3.29	0.06	1.47	3.41	3.13	3.98	0.56	0.11	99.7
S-8-1	59.36	24.03	3	0.05	1.41	3.11	3.59	4.21	0.62	0.13	99.6
S-11-1	64.28	19.16	2.35	0.03	1.33	4.3	4.13	4.4	0.72	0.15	99.89
S-18-2	66.67	18.78	3	0.07	1.03	1.53	3.66	4.78	0.53	0.15	99.78
S-18-3	64.25	18.42	3.44	0.04	1.58	3.64	3.85	4.71	0.75	0.18	99.79

REE	S-1-3	S-1-4	S-4-2	S-4-3	S-3-4	S-3-1	S-3-3	S-8-1	S-11-1	S-18-2	S-18-3
Sm	5,1	4,4	4,4	5,2	4,7	2,2	5,5	5,2	6	6,3	5,7
Ba	626	739	746,3	716,3	714,9	562,9	697,3	754,6	713,4	807,9	785
La	26	24	27	27	35	10	32	37	23	48	36
Ce	58,6	47,8	57,6	66,8	75,3	24,3	69,6	72,1	57,9	97,9	75,6
Ta	0,9	0,9	1	0,9	0,8	1,3	0,9	0,9	1,2	1,2	1
Eu	1	0,9	0,8	0,9	0,8	0,3	0,9	1,2	1,1	1,1	1,2
Gd	4,4	4	3,75	4,28	4	2,02	4,56	4,44	5,45	5,01	4,77
Tb	0,8	0,72	0,66	0,78	0,72	0,4	0,83	0,78	1	0,87	0,86
Er	2,61	2,46	2,23	2,51	2,36	1,48	2,75	2,41	3,3	2,8	2,82
Yb	2,35	2,26	2,17	2,48	2,24	1,55	2,64	2,25	2,85	2,71	2,63
Lu	0,4	0,4	0,4	0,4	0,4	0,3	0,4	0,4	0,5	0,5	0,4
Hf	3,1	6,8	6,7	6,6	6,3	4,1	6,9	5,3	6,9	6,8	7,3
Sc	12	11	9	10	9	1	10	9	9	7	11
Be	3	1	2	1	3	1	1	2	3	2	2
Th	15,5	14,9	15,2	15,2	14,5	15,5	19,3	10	19,6	21,9	12,1
Ga	16.7	16,3	16,8	16,6	17,5	15,2	16,1	18,4	18,3	16,8	16,1
Rb	89,8	114,4	122,9	100	125,4	90,1	136,6	110	92,8	150,6	110,2
Nb	10,6	10,7	11,5	11,4	10,7	9,5	12,8	12,2	16	13,8	13,4
Sr	543	482	371	510	487	263	248	422	555	276	418
Y	24,9	24,4	22,2	25,4	24,1	14,8	27,5	24,3	32,1	27,6	27,4
Zr	105	235	240	244	223	116	243	205	253	239	268
Pr	7,27	5,49	6,34	7,88	8,12	3,08	7,88	7,75	7,22	10,7	8,49
Nd	26,5	21,1	22,8	29,1	27,6	11,5	29,4	27,1	28,2	36,9	30,7
W	0,4	1	0,5	0,2	0,5	0	0,6	0,8	0,4	1	0,5

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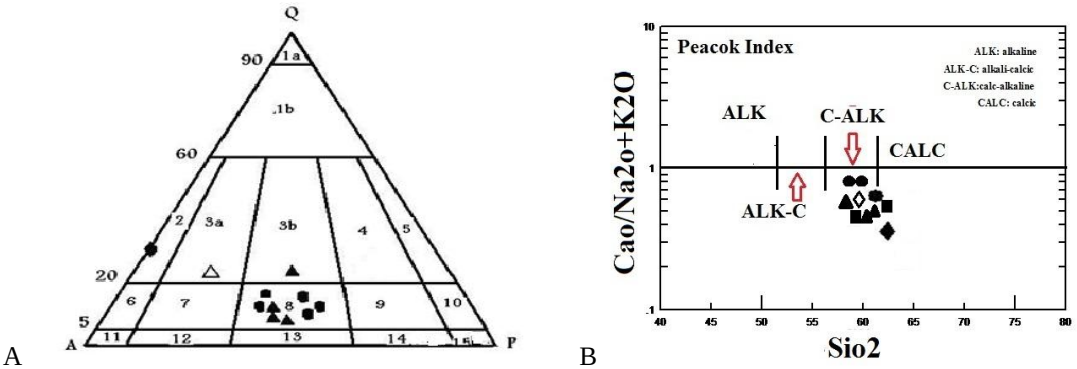


A B

Fig. 7: A: position of the samples in the study area - Figure Classification and streckeisen km (1979) B: Peacock index charts versus SiO2. (Pksrylv and Taylor, 1976).
▲: granodiorite ●: quartz ♦: alkali feldspar granite ◇: Monzogranite

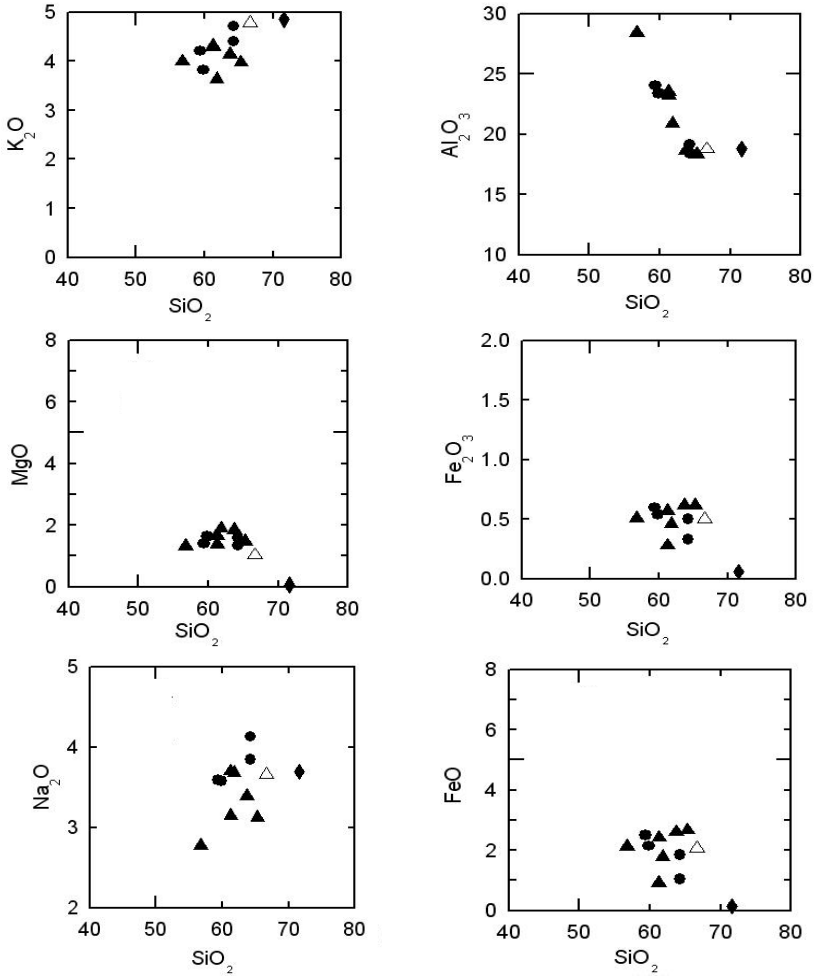
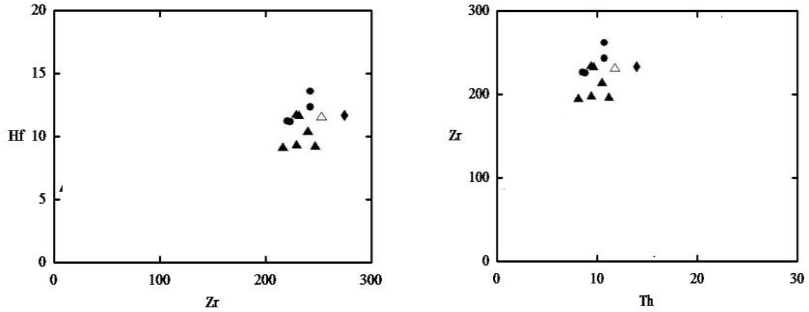


Fig. 8: Diagrams and index Harker subtracted. As shown in Figure 3 can be used signs.



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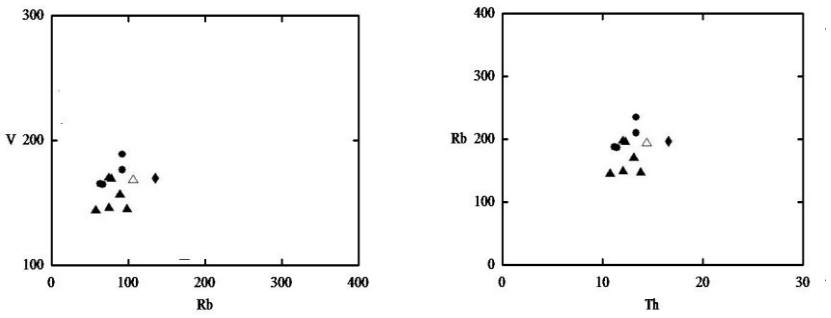
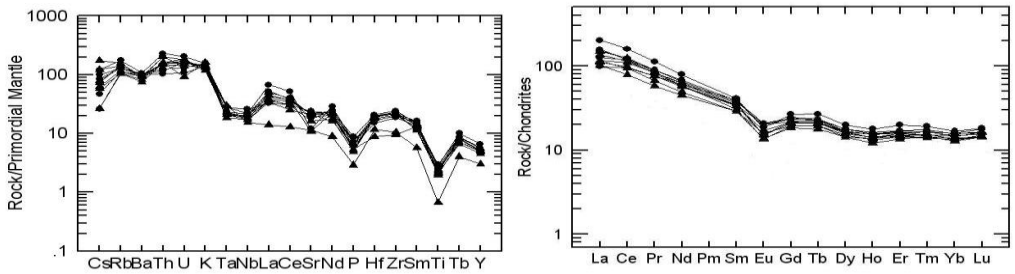
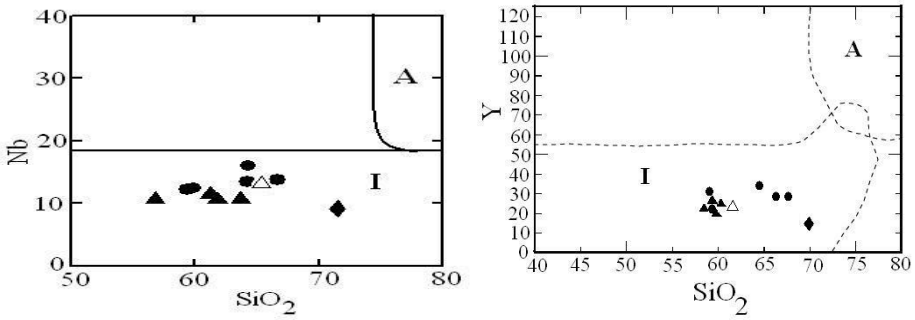


Fig. 9: Diagram of compatible and incompatible elements in the encapsulation.



A B

Fig. 10: A: Nmvdarsan and Mac Dvnvf (1989) for granitic rocks. B: Figure Greenwood *et al* (1980)



A B

Fig. 11: A: wt% SiO2 vs. Nb diagram for the differentiation of A-type granitoids and I (Coleman *et al*, 1986). B: plot Y versus SiO2 wt% for the differentiation of A-type granitoids and I (Furness *et al*, 1996).

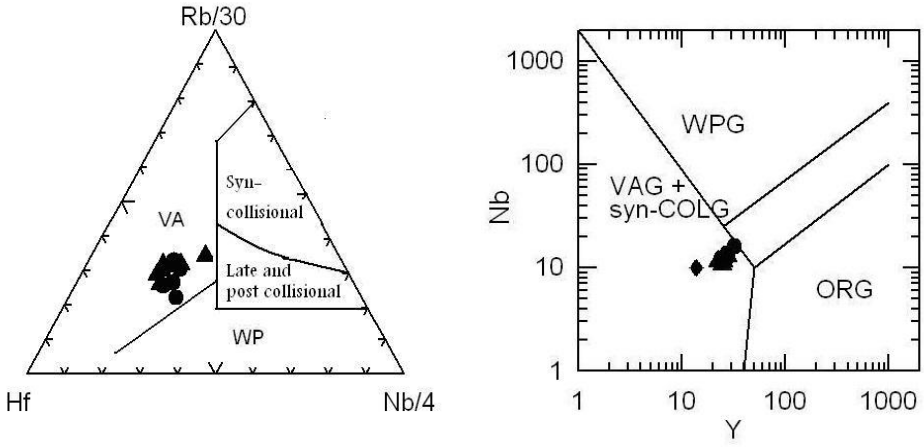


Fig. 12: Graph Pierce and colleagues (1984). Graph Harris *et al* (1986).

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Barbarn (1996) as the most peraluminous granitoids by partial melting of crustal rocks A are obtained. Nokhe granitoid rocks have high K, calc-alkaline series and I belong to. The rocks of the elements Nd, K, Ce, La, Rb and Th enrichment and the elements P, Ta, Nb, Sr, Ba and Ti negative anomalies are shown. The rocks in the Rb / Sr ratios and high Sr /Y (in samples less than 20) and Sm / Nd is low. In order to better identify the source of the magma rock-forming region, the ratios of some trace elements in these rocks, the ratios of the compounds of primitive mantle (PM), skew normal (N-MORB) and the average composition of the continental crust - a (Cont. C.av) were compared (Table 2). As seen in Table 2 to ratio of Th / La, Zr / Nb, La / Nb, Ba / Th and Ba / La average continental crust composition of the study area near - is. This finding may indicate that the originating continental crust composition close to the figure of a magma rock-forming region. And experimental studies have suggested a variety of melt compositions of magmas in the crust is. Variety of compounds that can be metapelites and amphibolites, gneisses and Metagrivake pointed. As shown in Figure 13a,c are seen to be melts from melting of crustal rocks, mafic melts from melting of felsic rocks Mtagrivake and plates with less than Al2O3/FeOt + MgO + TiO2, Na2O + K2O/FeOt + but MgO + TiO ratio CaO / FeOt + MgO + TiO2 are higher. According to this ratio Nokeh granitoid rocks (Figure 13 - b - c) and high Mg ≠ (45-70) (Mg / (Mg + Fe-+2) × 100] [molar Mg ≠) in the source rocks of the crust Nokeh is recommended for the lower rocks. Dhydarthe melting of mafic rocks at 700 to 1000 ° C and a pressure of less than Gpa5 / 1 to produce molten aluminum-rich trondhjemite is. The residual melt rich in plagioclase, amphibole and garnet are. But under pressure from Gpa5/1 trondhjemite molten aluminum produced poor calc-alkaline nature of the composition of diorite /granodiorite may vary (Rapp *et al*, 1991). The high rate of CaO, negative anomalies of Eu, Sr and depletion of REE elements in plagioclase indicate the source. The decrease of Y, the ratios of La / Yb (67/17-17/8) and Ta/Yb (34/0-31/0), the amount of low enriched in HREE and LREE elements in rocks indicate the presence garnet in the source. The origin of amphibole in the area to reduce the amount of TiO2, Rb/Sr, and K/Rb in the resulting melt is (Trtvn Pat Ford, 1996). The melts were derived from a source containing amphibole relatively large quantities of Ba and Ba/Rb are as (Furman and Graham, 1999). Thus melting mafic rocks in the crust beneath the pressure of 1 to Gpa2 / 2 and a temperature of 850 to 1100 ° C to produce considerable amount a melt (quartz diorite to tonalite) and, which scum of melt-rich plagioclase, amphibole and is the garnet. Especially if a high conductivity region is provided (Rushmer, 1991; Beard and Lofgren, 1991; Wolf and Wyllie, 1994; Rapp and Watson, 1991; Patino and Beaed.1995; Vandelaan and Wyllie, 1992; Sen and dunn, 1994).

Table 2: Comparison of the ratios of Ba / La Th / La, Zr / Nb, La / Nb, Ba / Th rocks of different proportions of the various combinations of primitive mantle (PM), skew normal (N-MORB) and the average composition of the crust a continental (Cont.C.av)

Number of samples	Zr/Nb	Ba/La	La/Nb	Ba/Th	Th/La
S-1-3	9.867925	23.71212	2.490566	40.3871	0.587121
S-1-4	21.91589	30.41152	2.271028	49.59732	0.613169
S-4-2	20.86957	27.74349	2.33913	49.09868	0.565056
S-4-3	21.4386	26.33456	2.385965	47.125	0.558824
S-3-4	20.85981	20.36752	3.280374	49.30345	0.413105
S-3-1	12.17895	56.29	1.052632	36.31613	1.55
S-3-3	18.98438	21.72274	2.507813	36.12953	0.601246
S-8-1	16.82787	20.39459	3.032787	75.46	0.27027
S-11-1	15.80625	30.61803	1.45625	36.39796	0.841202
S-18-2	17.31884	16.86639	3.471014	36.89041	0.457203
S-18-3	20	21.9888	2.664179	64.87603	0.338936
S-19-1	17.77419	25.87542	2.395161	69.23423	0.373737
S-23-3	9.575581	27.52153	1.215116	239.6667	0.114833
S-23-5	8.525424	28.79909	1.237288	252.28	0.114155
S-24-1	9.137615	21.59124	1.256881	164.3333	0.131387
S-28-1	10.11278	66.51648	1.368421	605.3	0.10989
S-25-1	8.29878	51	1.146341	737.5385	0.069149
Reference e	Values from	Weaver(1991)			
HIMU-mini	2.7	6.2	0.66	39	0.1
HIMU-max	5.5	9.3	0.77	58	0.2
EM1-mini	3.5	11.3	0.86	80	0.1
EM1-max	13.1	19.1	1.19	204	0.2
EM2-mini	4.4	7.3	0.89	57	0.1
EM2-max	7.8	13.5	1.09	105	0.2
P.M	14.8	4.3	0.94	77	0.1
N-MORB	30	9	1.07	60	4
Cont.cav	16.2	54	2.2	124	0.2

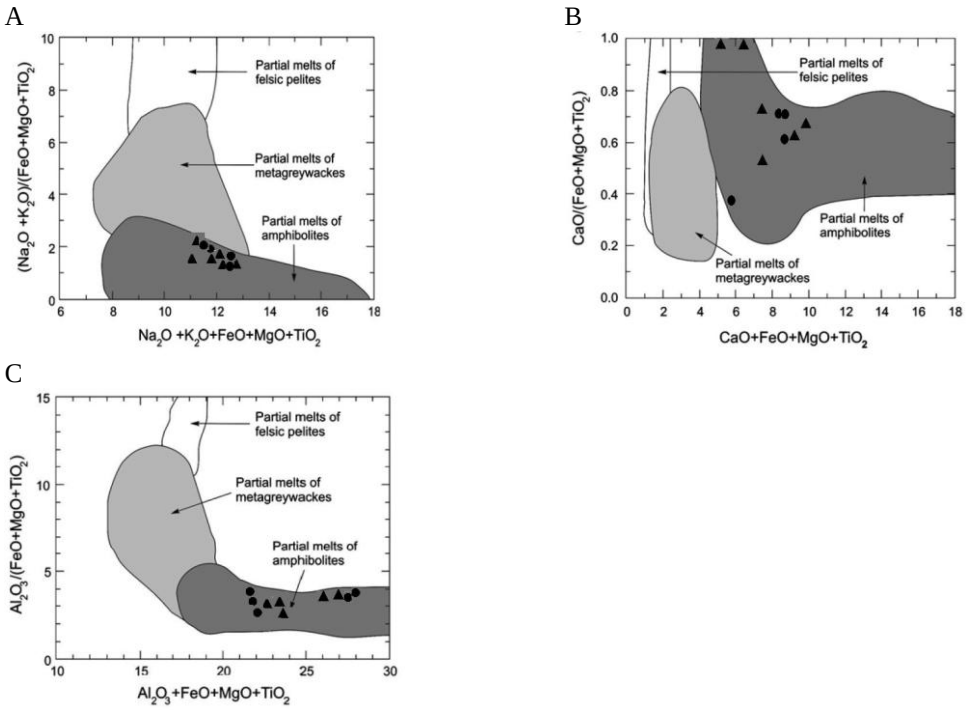

Fig. 13: Location of the study area in diagrams (1999) Patino Douce to show their origin

Conclusions:

The study involved analysis of geochemical data of granitoids of the Nokeh concludes that:

- According to Norm diagrams and chemical classification of volcanic rocks range from granodiorite rocks Nokeh, micro-granite, and alkali feldspar granite are considered.
- The process of fractional index of silica and oxides of major elements versus SiO_2 values generally increased with the amount of K2O, Na2O and index fractionation will increase. But the amount of Al_2O_3, MgO, Fe_2O_3, CaO, MnO and TiO_2 reduction will be. These changes indicated that the intrusion of a mass fractionation has been studied.
- Evaluation of trends in silica and trace element fractionation index indicates increasing amounts of Ba, Rb, Zr and Sr decrease with increasing SiO2 and the subtraction index.
- The Y versus Zr diagram is clear that the intrusion of fractional crystallization phenomenon has been studied area.
- Increase in the Rb / Sr ratio and Sr indicate plagioclase fractionation in the early phase and decreasing K /Rb associated with increased markers of potassic feldspar in the rocks.
- P2O5 and TiO2 decrease with the progression of subtraction ¬ studied samples may be due to reduction of secondary phases such as apatite, rutile and zircon are subtracted from the melt during operation.
- All of the graphs Petrological study of various processes metaluminous to peraluminous granitoids in the range of weak alkaline shown be cause.
- Nb negative anomalies can be caused by magma mixing and impregnation of shell material is.
- According to the diagrams used to distinguish different types of granites, granites in the study area as I type - are.
- Fusion of lower crust (mafic composition) has led to the production of granitic melts. Granitic melt the crust cooled slowly, leading to the formation of the granitoid rocks are Nokeh. However, due to metasomatic fluids exchanging elements between granitic melt and country rocks in the area have been skarnition. Of large quantities of Ba and Ba/Rb are as (Furman and Graham, 1999). Thus melting mafic rocks in the crust beneath the pressure of 1 to Gpa2/2 and a temperature of 850 to 1100 ° C to produce considerable amount a melt (quartz diorite to tonalite) and, which scum of melt-rich plagioclase, amphibole and is the garnet. Especially if a high conductivity region is provided (Rushmer, 1991; Beard and Lofgren, 1991; Wolf and Wyllie, 1994; Rapp and Watson, 1991; Patino and Beaed.1995; Vandelaan and Wyllie, 1992; Sen and dunn, 1994).

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