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Case Study

Petrogenesis and Tectonic Environment of Granites, Eastern Ghats, South India- A Case Study

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Abstract This study presents the geochemical characteristics of granitic rocks located a part of the Eastern Ghats which lies to the east of Cuddapah basin (Obachettapalem in Prakasam district, A.P). These granites are typically uniform as is evident from the chemical and modal classification. The field, petrographic and petrochemical studies explain the magmatic nature of the granites. The magma of these granites is peraluminous and calc-alkaline nature and emplaced as syn-collision environment and crystallised at 650^{o}C to 700^{o}C at 5 to 7 kb of PH_2O.
Keywords *Petrogenesis; Peraluminous; Calc-alkaline; Syn-collision*

1. Introduction

The study area (Obachettapalem, Prakasam district, South India) forms that part of the Eastern Ghats which lies to the east of Cuddapah basin (between 15°35' - 15°41' N latitude and 79°43' – 79°51' E longitude). The area forms an igneous and metamorphic complex having a variety of rocks viz., charnockite series (pyroxene granulites and charnockites), khondalites series (paragneisses and quartzites), granites, dyke rocks and pegmatites in the order of their abundance. The chronological sequence of the various rock units has been worked out purely on the contact studies in the field.

In the field, the granites are massive and even some exhibit banded appearance. The banding which is due to the alteration of the bands consisting of felsic and mafic constituents is very clearly displayed particularly when it is close to the pelitic gneisses. The foliation strikes N 10^{0}W to N 20^0 W and dips at higher angles towards the east; with an angle of 50^0 to 55^0 East to vertical. At few places, the trend of foliation changes towards N 20^0 E retaining the dip in the same direction.

The granites come into contact with the pelitic gneisses and with the charnockites. The contact between the granites and gneisses is considered to be gradational. In the western portion of the area the pelitic gneisses and granites are in contact (Figure 1).

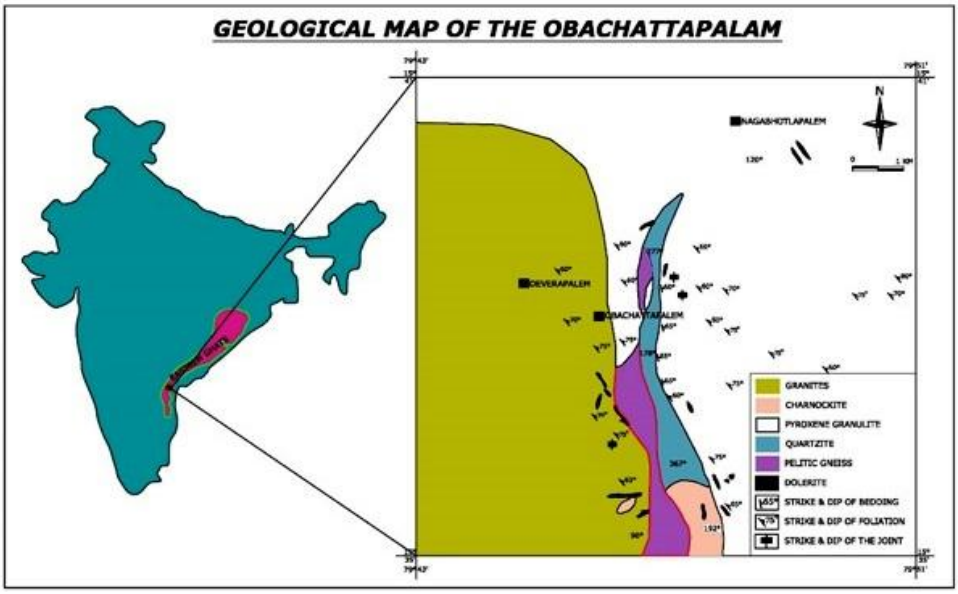

Figure 1: *Location and Geological Map of the Study Area*

Granite is seen in association with charnockites in southern portions of the area. This association has significance in the evolution of the charnockites. Charnockite is seen as a lenticular patch in granite in the southern portion of the area; and also occurs with gradational contact with granites. In some places granite is intruded into the charnockite, which in turn is intruded by dolerite. The coarse fractions of the granites are considered to be pegmatites, while fine portions of leucocratic gneisses are considered to be aplites. In the plains of the southwestern portion of the area, pegmatites and aplites cut across the granites indicating both pegmatites and aplites are the later phases in the evolution of the granites.

The major sets of joints are noted, one paralleling the foliation (N 20^{o} W) and another cutting across it (about E-W), and the third paralleling the topographical surface. These are called L, Q and horizontal joints of sheeting (Cloos, 1937). Both Q and L joints are localized with the dolerite dykes.

2. Method of Study

Our researches in this study consist of two parts: field and laboratory studies. Field studies include identifying the different phases of intrusion, relationship between them and host rock and finally sampling of different phases for laboratory studies. Laboratory investigations include preparing of 40 thin section and petrographic studies, analyzing of 9 samples by ICP-AES and ICP-MS for major, trace and rare earth elements at the PURSE Centre, S.V. University, Tirupati, and National Geophysical Research Institute (NGRI), Hyderabad. Finally, these analyses were processed by using Excel, GCD Kit and IGPET programs.

Petrography

For description and classification purpose, modal compositions are best suited. Johansen (1938); Chayes (1952, 1957); Bateman (1961) and some of the earlier workers who proposed classification of granitic rocks based on modes. The quartz, potash feldspar and plagioclase values, when reduced to 100 and plotted in the trilinear diagram (Figure 2), the rocks have a place in granites. Though all the points lie in the granite field, they occupy different positions within the field reflecting the compositional variations. Streikensen (1973) classification has incorporated the views of the earlier workers and the same is followed in the present work.

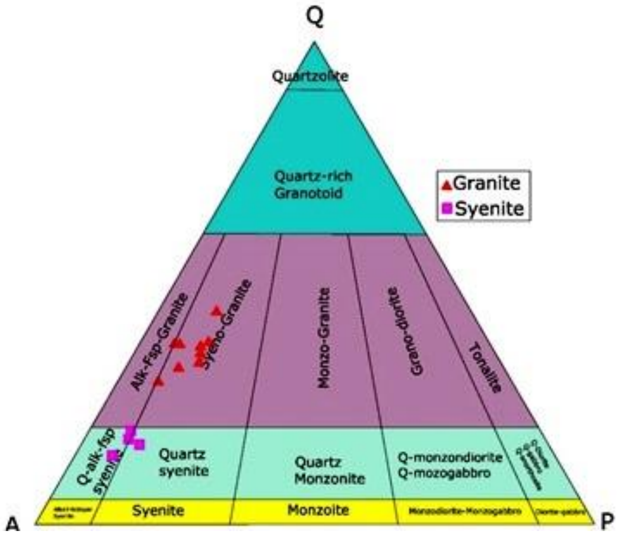

Figure 2: *Quartz (Q) - K-Feldspar (A) - Plagioclase diagram (after Streckeisen, 1973)*

Granites

Granite is a hard compact, coarse – to medium – grained rock with grey colour. The rock exhibits allotriomorphic texture with anhedral grains of perthite, quartz and plagioclase as felsics, and hornblende, biotite and iron ore as mafics. Perthite is noted in large quantities. Wherever perthite intergrowth is noticed, potash feldspar exhibits turbidity, and quartz inclusions are present in perthite. Plagioclase of vein type is present in potash feldspar giving perthitic intergrowth. Sometimes plagioclase is also seen as inclusions in perthite. Hornblende occurs in considerable quantities and only at one or two places it is seen developing after the orthopyroxene. The hornblende grains are riddled with iron ore inclusions. A few small biotite flakes and irregular grains of iron ore noted all over the section. Apatite inclusions are present in almost all the minerals. The modal compositions of the granites are given in Table 1.

Syenite

This is a coarse – grained rock which is hard and compact. The coarse crystals of feldspar and hornblende are seen very clearly. In thin sections, the rock is found to be made up of mostly perthite with smaller portion of quartz and plagioclase. Plagioclase blebs are uniform in potash feldspar host and in most cases confined to the core portions of host, not extending to the marginal portions. The hornblende grains are irregular in distribution and exhibit two sets of cleavages. It shows pleochroism from yellowish-green to green. The coarse nature of the perthite grains indicate that they are crystallized when the magma had considerable amount of volatiles. The modal composition of these rocks is given in Table 1.

Table 1: *Modal Composition of Granites (In volume percentage)*

Sample No	1/70	2/74	3/78	4/103	5/7	6/72	7/73
Quartz	36.58	27.35	30.53	30.10	26.04	32.18	29.07
K-Feldspar	49.08	44.56	45.74	54.52	56.22	48.53	43.33
Plagioclase	11.92	10.23	5.95	8.78	6.52	5.65	9.54
Orthopyroxene	-	-	-	-	0.39	0.48	-
Hornblende	-	6.65	7.63	2.74	3.32	4.19	8.32
Biotite	4.42	9.25	8.92	2.00	3.44	7.89	6.11
Apatite	-	0.57	-	-	1.17	-	0.96

Iron ore	1.00	1.39	1.24	1.86	2.90	1.08	2.67

Sample No	**8/18**	**9/135**	**10/142**	**11/13**	**12/77**	**13/108**	**14/3**
Quartz	31.90	36.51	29.76	16.21	15.15	11.21	14.25
K-Feldspar	48.34	38.07	43.20	61.21	63.96	62.12	62.30
Plagioclase	5.86	8.70	9.30	6.20	6.70	5.20	8.80
Orthopyroxene	0.86	-	-	-	-	-	-
Hornblende	6.78	6.30	7.16	8.82	6.26	9.17	6.16
Biotite	2.74	7.11	7.90	5.90	5.20	9.14	5.81
Apatite	-	-	-	-	0.64	-	0.84
Iron ore	4.23	3.31	2.68	1.68	2.01	3.16	1.84

1-10: Granites 11-14: Syenites

Pegmatite and Aplite

These are quite similar to that of granites. Pegmatite is considered to be only as a textural variant of granite. Aplite is similar in composition to granite, but it does not contain mafics, the difference between them is in granularity. The pegmatite is very coarse-grained, rich in potash feldspar and quartz, whereas aplites are fine-grained and contain quartz, perthite and plagioclase, and both exhibit graphic intergrowth. But for the difference in texture, the aplite and pegmatite are same in composition.

Petrochemistry and Petrogenesis

The results of chemical analysis of the granitic rocks together with CIPW norm, Niggli values are given in Table 2.

Major elements

SiO_2 varies from 63 to 69%, Al_2O_3 from 13.5 to 16.6%, FeO (total) from 3.5 to 6.5%, MgO from 1.4 to 2.6%, CaO from 0.4 to 1.8%, Na_2O from 2.2 to 3.06%, K_2O from 4.2 to 6.8%, TiO_2 from 1.0 to 2.5%, P_2O_5 from 0.13 to 0.20% and MnO from 0.13 to 0.25%. The plots on normative albite (Ab)-anorthite (An)-Orthoclase diagram (O'Conner, 1965); SiO_2 vs Na_2O+K_2O of Cox et al., (1979) and Middlemost, (1994), (Figure 3) indicate the rocks of the present area as granites. Also, when the major Oxides data were plotted in the R_1-R_2 diagram of De La Roche et al. (1980), the R_2 is plotted along the Y –axis and is defined as R_2=(Al+2Mg+6Ca), and R_1 on X – axis as R_1= 4Si-11(Na+K)-2(Fe+Ti). All the plots fall in the granite and granodiorite fields only (Figure 3).

Table 2: *Major element concentrations of granites C.I.P.W. Norm values*

	1/70	2/74	3/78	4/103	5/7	6/72	7/73	8/18	9/135	10/142
SiO_2	69.09	69.94	67.9	71.51	68.83	70.93	70.5	71.9	71.6	70.03
Al_2O_3	16.6	17.71	16.28	16.61	14.27	15.1	16.19	15.02	14.39	16.01
Fe_2O_3	1.53	1.14	1.16	0.3	1.26	1.57	1.75	0.27	1.76	2.04
FeO	1.63	0.92	1.95	0.71	1.31	1.48	1.06	1.2	1.72	1.4
MgO	0.48	0.41	0.73	0.48	0.49	0.76	0.48	0.69	0.46	1.46
CaO	1.24	2.06	2.04	1.08	2.44	2.52	1.21	1.35	1.68	0.36
Na_2O	3.2	4.32	3.65	4.35	4.75	3.65	2.21	3.8	2.2	2.4
K_2O	4.93	2.84	4.58	4.25	3.48	2.47	3.29	4.03	4.26	4.1
TiO_2	1.02	0.17	1.06	0.14	0.49	0.37	1.02	0.26	0.37	1.03

P_2O_5	0.14	0.06	0.16	0.05	0.22	0.19	0.13	0.14	0.16	0.15
MnO	0.06	0.04	0.13	0.02	0.15	0.05	0.16	0.03	0.15	0.15
H_2O	0.19	0.42	0.4	0.82	0.4	0.53	0.11	0.91	0.35	0.52
Total	**100.11**	**100.03**	**100.04**	**100.32**	**98.09**	**99.62**	**98.11**	**99.6**	**99.1**	**99.65**
Quartz	28.567	28.848	23.633	26.668	22.891	33.846	42.12	30.123	38.048	37.861
Corundum	4.08	3.927	1.992	3.01	0	2.295	7.104	2.287	3.488	7.328
Orthoclase	29.135	16.784	27.066	25.116	20.566	14.597	19.443	23.816	25.175	24.23
Albite	27.078	36.555	30.885	36.808	40.193	30.885	18.7	32.155	18.616	20.308
Anorthite	5.237	9.828	9.076	5.031	7.337	11.261	5.154	5.783	7.29	0.806
Diapside	---	---	---	---	2.722	---	---	---	---	---
Hypersthene	1.352	1.563	2.932	2.058	0.724	2.796	1.196	3.326	2.518	3.637
Magnetite	2.219	1.653	1.682	0.435	1.827	2.277	0.982	0.392	2.552	2.016
Ilmenite	1.938	0.323	2.014	0.266	0.931	0.703	1.938	0.494	0.703	1.957
Hematite	0	0	0	0	0	0	1.073	0	0	0.65
Apatite	0.332	0.142	0.379	0.118	0.521	0.45	0.308	0.332	0.379	0.355
Total	**99.937**	**99.622**	**99.659**	**99.511**	**97.712**	**99.109**	**98.018**	**98.706**	**98.769**	**99.149**

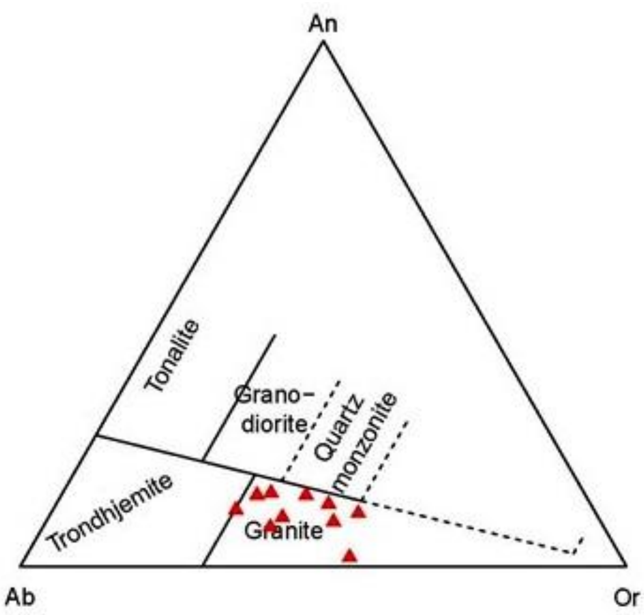

Figure 3A: *Normative Ab-An-Or diagram (O'Conner, 1980)*

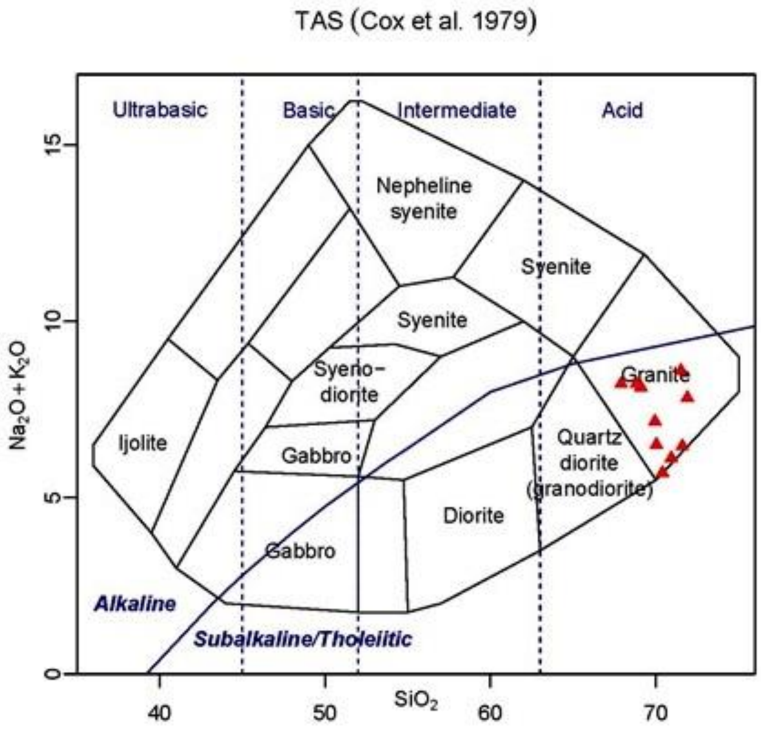

Figure 3B: *SiO_2 vs. $Na_2O + K_2O$(TAS) diagram after Cox et al. (1979)*

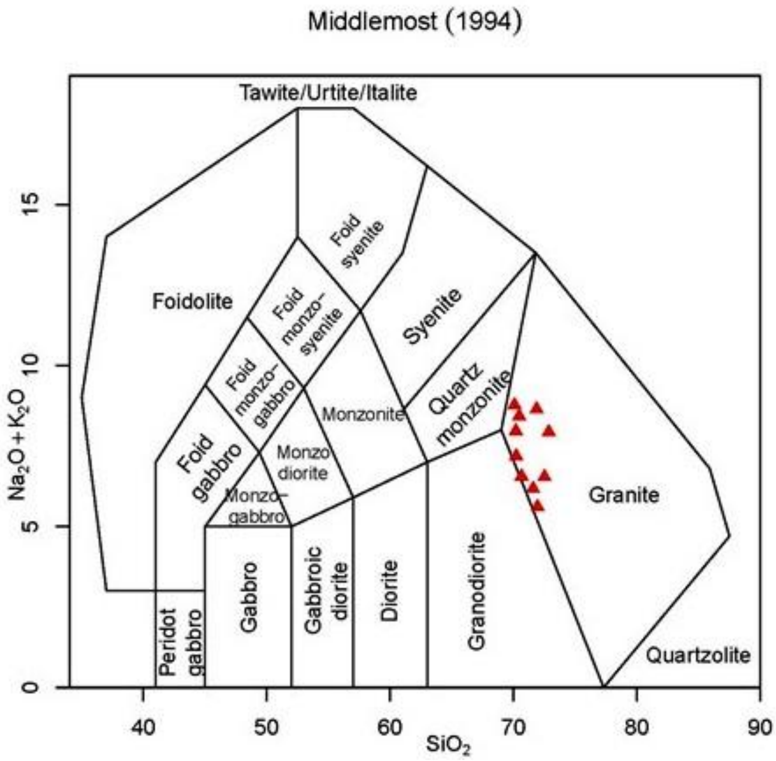

Figure 3C: *TAS diagram classification of rocks in the total alkali-silica diagram (Middlemost, 1994)*

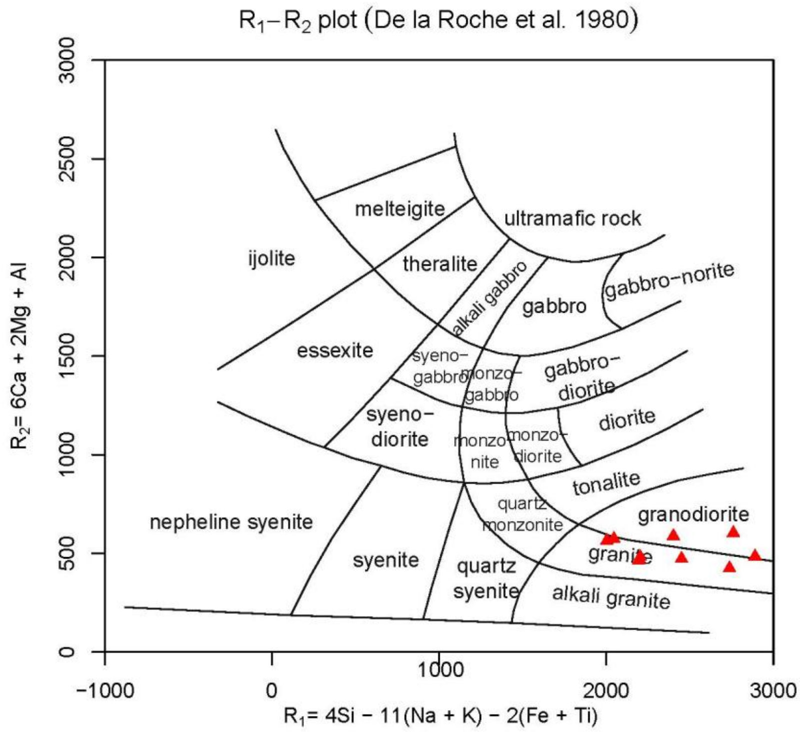

Figure 3D: *R1-R2 diagram of De La Roche et al. (1980)*

The figure (Shand, 1943) shows that the alumina saturation index indicates that these granites are of strong peraluminous with corundum and anorthilte normative; with both Agpatic Index and Alumina saturation Index are >1 (Figure 4a). The characteristic mineral diagram (Figure 4b) which is a measure of Dark minerals [B= Fe +Mg +Ti] and aluminous character [A= Al-(K+Na+2Ca)] also indicates a peraluminous nature of the rocks (Debon and Le Fort, 1983). The peralumious character demonstrated by the A-B diagram reflects the presence of boitite. Generally, granitiods plotting in the peraluminous domain have been derived from anatexis of granitiods magma by first- cycle assimilated intermediate to acid volcaniclastic basin sediments (Leube et al., 1990; and Liaozhongli et al., 2007, Al-Qadhi Abdul-Aleam Ahmed et al., 2016). A–B diagram after Villaseca et al. (1998), showing overall major element variation for the different suites. Two compositional domains are shown: with metaluminous area A < 0 and peraluminous area A > 0. The study area granitoids are of moderate to high Peraluminous type (Figure 5).

Variation in major elements suggesting their chemistry has been modified by interactions with the magma. The study granatoids (SiO2 >60% have also having moderate FeO^t/(FeO+MgO) ratios (,0.8) being classified as Magnessian plutons (Figure 6). The plots of granites on A – F – M diagram (Figure 7) of Irvine and Barger (1971), and the SiO_2-K_2O diagram (Figure 8) of Paccerillo and Taylor (1976) shows that most of the samples fall wilthin high potash clac-alkaline and calc-alkaline series and only one sample in shoshonitic series. The alkaline affinity of these granites is demonistrated on the diagram of Sylvester (1989), which discriminates btweeen alkaline, clac-alkalline and highly fractionated calc-alkaline granites with SiO_2 >68 wt% (Figure 9). Negative trends presented by granites in CaO, P_2O_5, K_2O, TiO_2 and Al_2O_3 versus SiO_2 diagram of Harker (Figure 10), suggests that fractionation of apatite, alkali feldspar took place during the evolution of these granites.

Chappel and White (1974) stated that the rocks of igneous type have atomic ratios of Al/(Na + K + 2 Ca)= up to 1. The granites of the present area have a value of 0.9, indicating that these are igneous in nature.

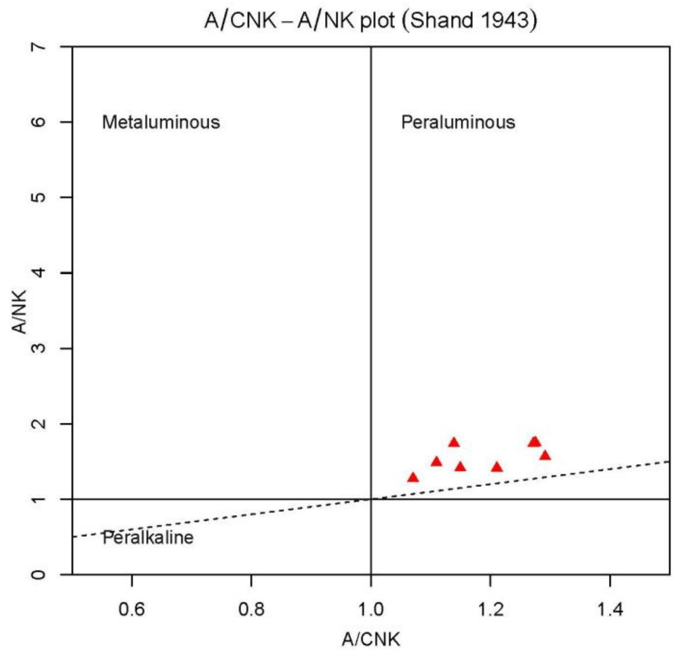

Figure 4a): *The figure shows that the alumina saturation index indicates that these granites are of strong peraluminous in nature (Shand, 1943)*

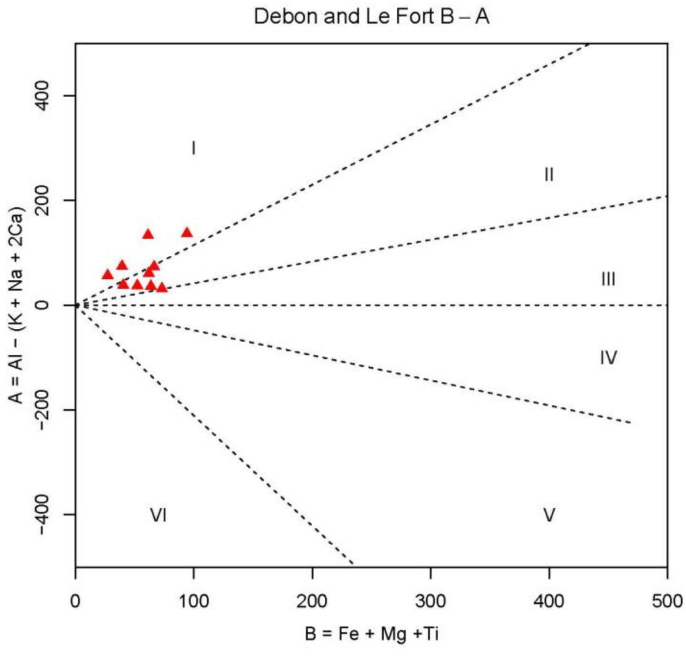

Figure 4b): *Distribution of granitic facies of (A versus B) of Debon & Le Fort (1983)*

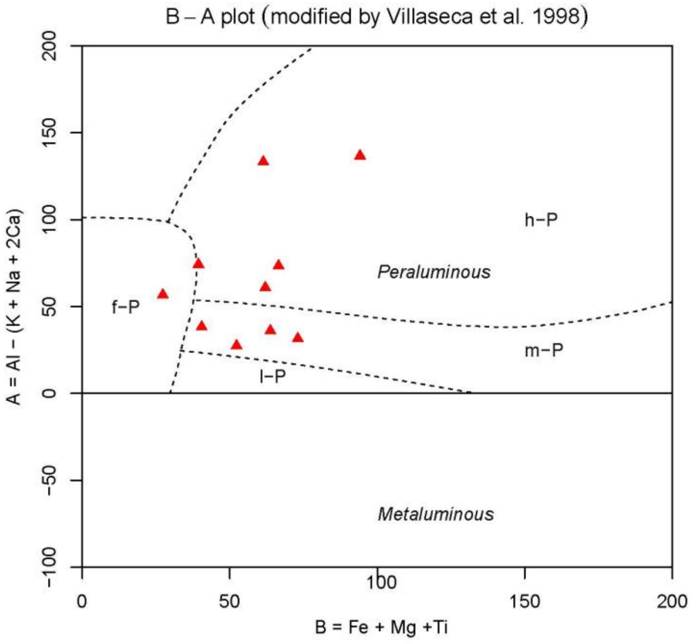

Figure 5: *B-A diagram after Villaseca et al. (1998)*

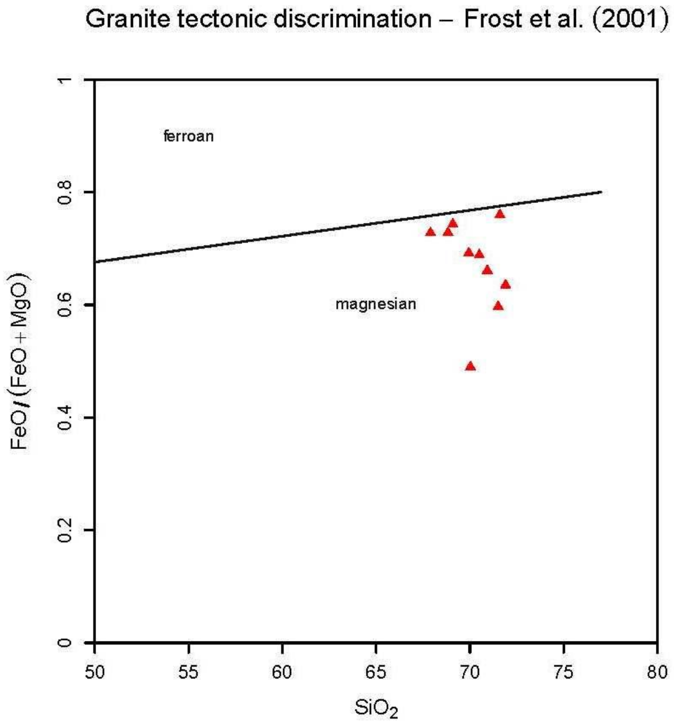

Figure 6: *Chemical classification of granites using FeO*/(FeO+MgO) vs SiO_2*

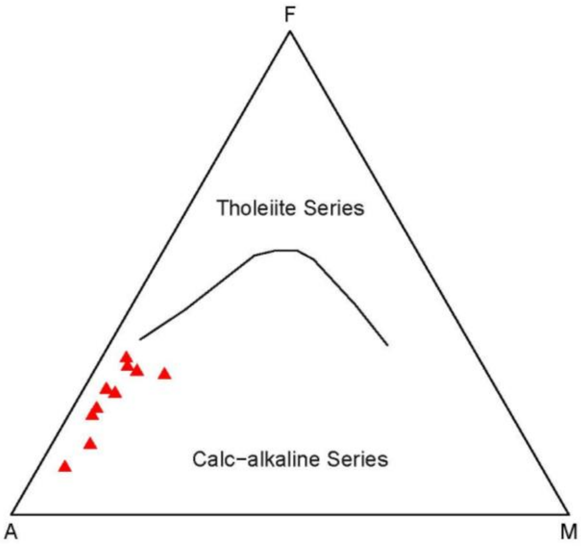

Figure 7: *AFM diagram of Irvine and Baragar (1971) indicating its cale-alkaline nature*

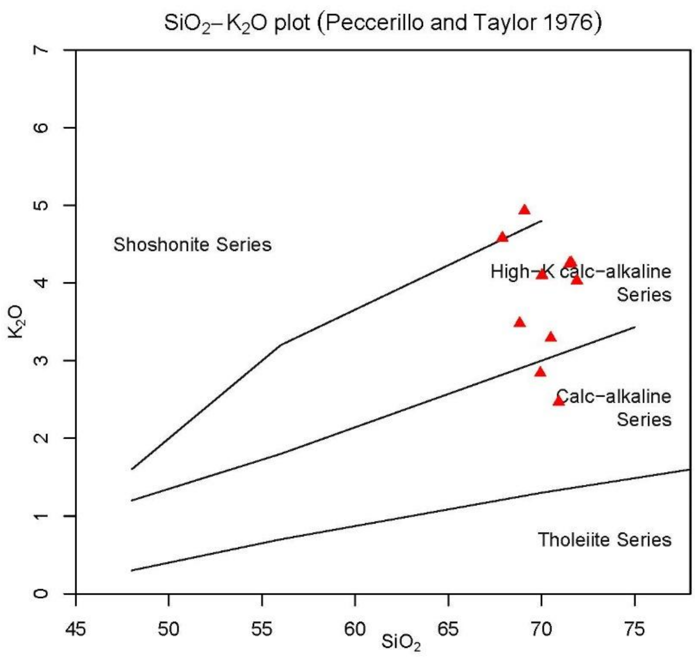

Figure 8: *SiO_2-K_2O diagram pf Paccerillo and Taylor (1976)*

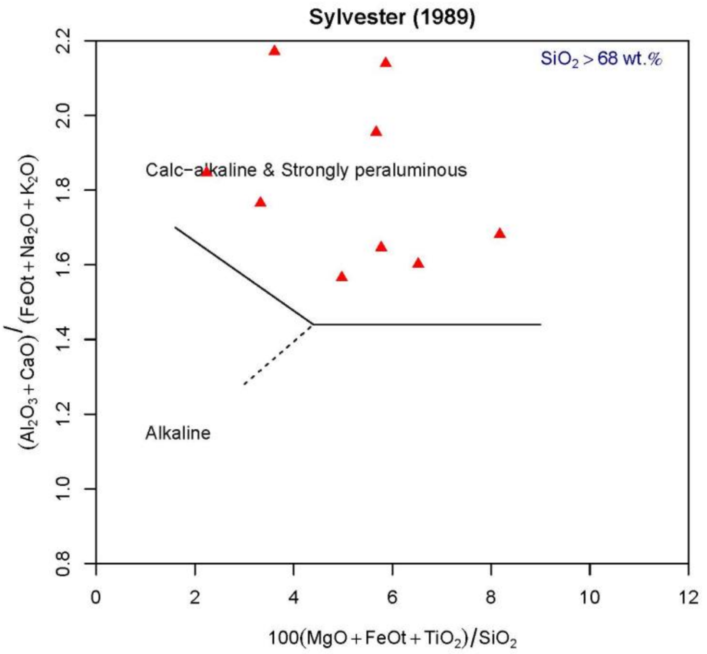

Figure 9: *Demonstrated on the diagram of Sylvester (1989)*

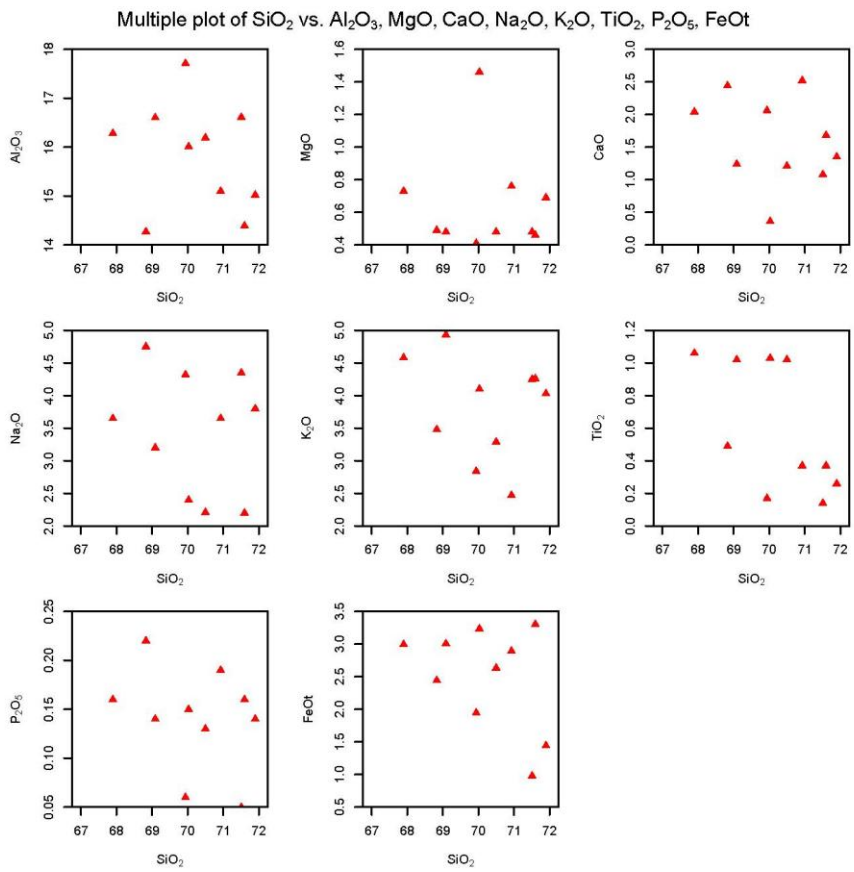

Figure 10: *Harker variation diagram for granites of the study area*

Trace and Rare Earth Elements

The trace element concentrations in a few representative samples are estimated and are given in Table 3.

Table 3: *Trace and Rare Earth Elements Concentrations in Granites*

Sample No	1/70	2/74	3/7	4/72	5/77	6/73
Trace Elements (ppm)						
Sc	9.30	9.90	6.40	6.40	7.90	8.60
Co	3.80	1.30	0.60	2.10	1.50	9.90
Ta	14.10	6.90	3.80	7.20	8.30	6.50
Ba	1550.00	1020.00	560.00	770.00	1610.00	1730.00
Rb	161.00	191.00	228.00	204.00	154.00	131.00
Th	42.00	49.00	53.00	22.50	44.00	24.00
Ce	-	1.38	-	2.10	-	1.20
Zr	530.00	570.00	320.00	450.00	1680.00	780.00
Hf	10.30	10.80	9.60	6.80	32.90	15.10
K/Rb	272.00	243.00	180.00	175.00	270.00	114.00
K/Ba	27.00	46.00	73.00	46.40	25.80	28.70
Ba/Rb	9.60	5.30	2.50	3.80	10.50	13.20
Zr/Hf	51.00	53.00	33.00	66.00	51.00	52.00
Ta/Hf	1.37	0.64	0.40	1.06	0.25	0.43
Rare Earth Elements (ppm)						
La	173.00	74.00	52.00	107.00	411.00	156.00
Ce	350.00	163.00	105.00	187.00	743.00	270.00
Nd	120.00	72.00	-	60.00	212.00	78.00
Sm	19.40	14.20	9.70	10.20	33.80	12.00
Eu	2.30	2.00	0.42	1.59	2.42	2.55
Tb	3.17	2.27	2.04	1.31	3.58	1.09
Yb	6.30	5.90	7.00	4.90	9.00	4.00
Lu	0.74	0.74	0.77	0.64	0.79	0.58
$(La/Yb)_N$	16.60	7.60	4.50	13.20	27.70	23.60
$(Ce/Yb)_N$	11.30	5.50	3.00	7.70	16.70	13.40
(Eu/Eu*)	0.39	0.47	0.14	0.33	0.28	0.90

In Figure 11 decreasing trends of Ba and Ba/Rb ratios and increasing trend of K/Ba ratio with increase in values of differentiation Index (D.I) are observed for the granites. Such trends are typical to the rocks originating through magmatic crystallization.

The REE contents of the selected samples of granites are presented in Table 3. The chondrite normalized patterns are shown in Figure 12. It can be observed from the graph that all the samples show marked negative Eu anomalies. Total REE and $(La/Yb)_N$ of these rocks vary significantly.

Zhonggang et al., (1982) divided the granites into three major categories in terms of Eu/Eu* values as Eu/Eu* values greater than 0.5; 0.3 to 0.4; and less than 0.2. From these values it can be stated that granites belonging to first category are older and closely connected to the process of granitization in origin, those of the second category are of magmatic origin while those of the third category are especially distinguishable for their characteristic features of magmatic differentiation and replacement. The granites of present area is mostly of the second category with Eu/Eu* of 0.28 to 0.47 indicating their magmatic affinity.

Fractional crystallization models focus on the production of higher silica in granitic rocks by crystallization of feldspar to increase the negative Eu anomaly during differentiation (Taylor, 1968; Emmerman et al., 1975; Condie et al., 1981; Cullers and Grof, 1984). Fractional crystallization of amphibole increases the REE content and negative Eu anomaly with increasing SiO_2 content (Rogers et al., 1980). These granites are similar to that of Gabro suite (Eu/Eu*= 0.5) and Mimbulla suite (Eu/Eu* = 0.3) of South Australia (Collins et al., 1982).

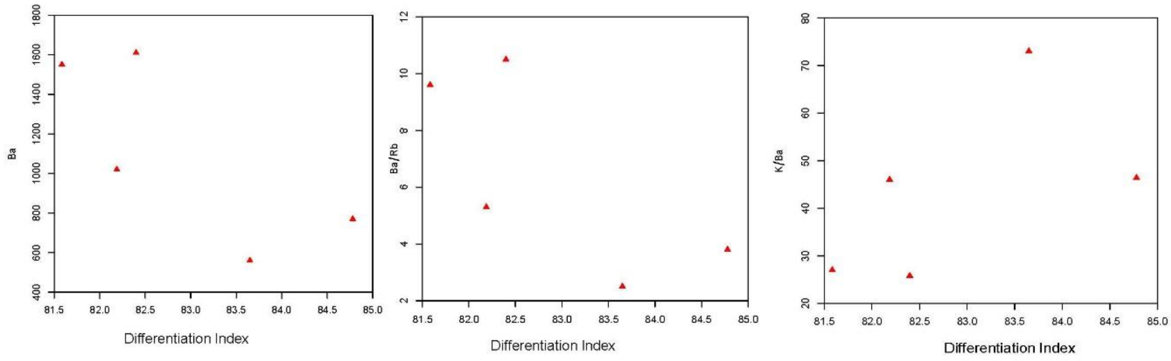

Figure 11: *Variation diagram of Ba, Ba/Rb and K/Ba vs Differentiation Index (D.I.)*

Tectonic evolution

The generation of granitic liquid is directly and indirectly related to tectonic activity, whether associated with extensional or compressional movement. Strong correlation between the types of granites and tectonic settings have been pointed out by Streckeisen (1974); Pearce et al. (1984); Pitcher, (1983); Patchet and Ruiz (1987); Lameyre (1988); Pupin (1988); Maniar and Piccoli (1989); Barbarin (1990); Bonin (1990); and Eby (1990). Fyfe (1988) believes that collision mechanisms or collision thickening provide a suitable mechanism in crustal melting for large granite masses with continental crust chemistry and isotope systematics. Thus, it seems there exit a direct link between the tectonic setting and granite generation.

Harris et al. (1986) have presented a comprehensive picture of geochemical characteristics of collision zone magmatism and proposed four groups of granite intrusion, each associated with a particular stage in the tectonic evolution of a collision zone. They are: (i) Pre-collision calc alkaline (volcanic-arc) intrusions that are mostly derived from mental modified by a subduction component and are enriched in LIL element. (ii) Syn-collision peraluminous intrusions which may be derived from the hydrated bases of continental thrust sheets. (iii) Late or Post-collision calc-alkaline intrusions which may be derived from mantle source but undergo extensive crustal contamination and contain higher ratios of Ta/Hf and Ta/Zr than volcanic-arc intrusions (iv) Post-collision alkaline intrusions which may be derived from mantle lithosphere beneath the collision zone which has high concentration of both LIL and HFS element.

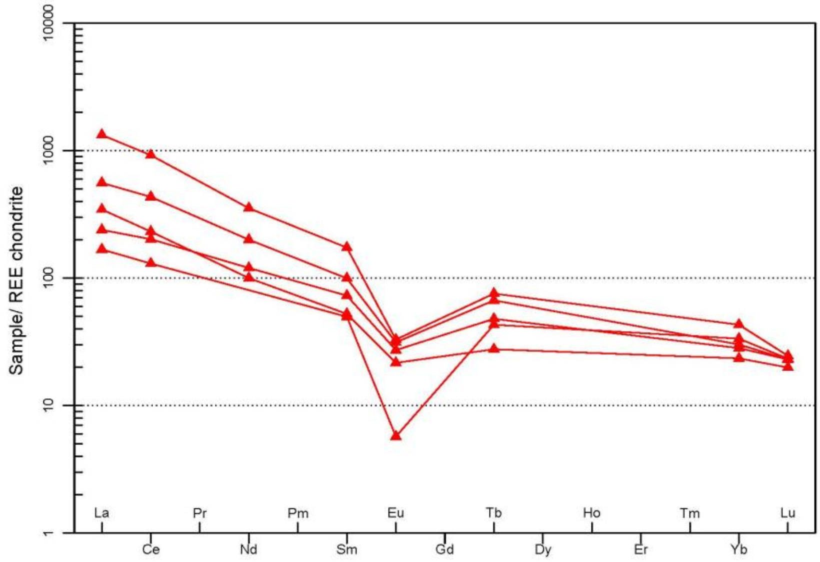

Figure 12: *Condrite normalized REE patterns for granites*

Aluminum Saturation Index

The chemical compositions of the study area granites are reported in Table 2. The SiO_2 content of the representative samples vary from 66 to72 wt.%. The high alumina content (Al_2O_3: 14-17 wt. %) relative to alkalies (Na_2O:22-47 wt. % and K_2O:2.8-4.9 wt. %) and calcium (CaO: 0.36-2.52 wt. %) is reflected in a high percentage of normative corundum and a high molecular ratio Al2O3 (A/CNK). These samples with low FeO display broadly magnesian character. The study area granite samples plot in the Orogenic belt field on the MgO-Fe_2O_3 $_{(t)}$-Al_2O_3 ternary plot after Pearce et al. (1977) (Figure 13). The Figure 14 shows that the aluminium saturation index indicates that these are strongly peraluminious and syn-collision type. Same was also observed by Darvishi et al., (2015) in Maggiyan granites of N-W Iran.

R2-R2 Parameter

Batchelor and Bowden (1985) distinguished granite into different tectonic setting using a main granite rock assemblage diagram (Figure 15). R1 and R2 values can be recalculated according to the main oxide content of granites. Most of the samples are located in the syn-collision granite area. This indicate the granites of this area is located in the upper crust, separation and crystallization of mineral occur only in part of the rock, and melting occurs in most of the rock. So, the granites tectonic setting is syn-collision setting.

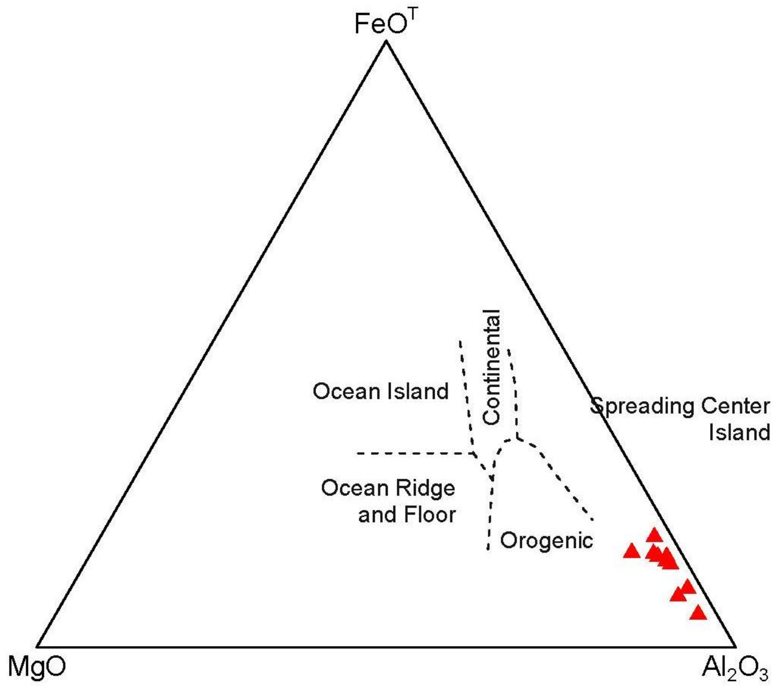

Figure 13: *MgO-Fe2O3 (t) - Al2O3 ternary plot after Pearce et al. (1977)*

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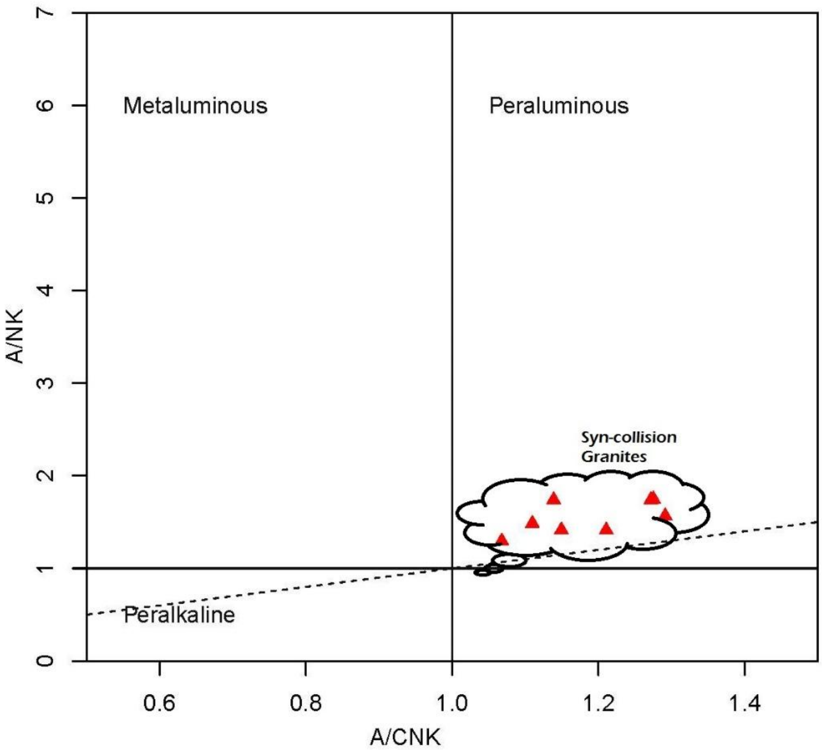

Figure 14: *Sand's Index for the studied granites, field after Maniar and Piccollo (1989)*

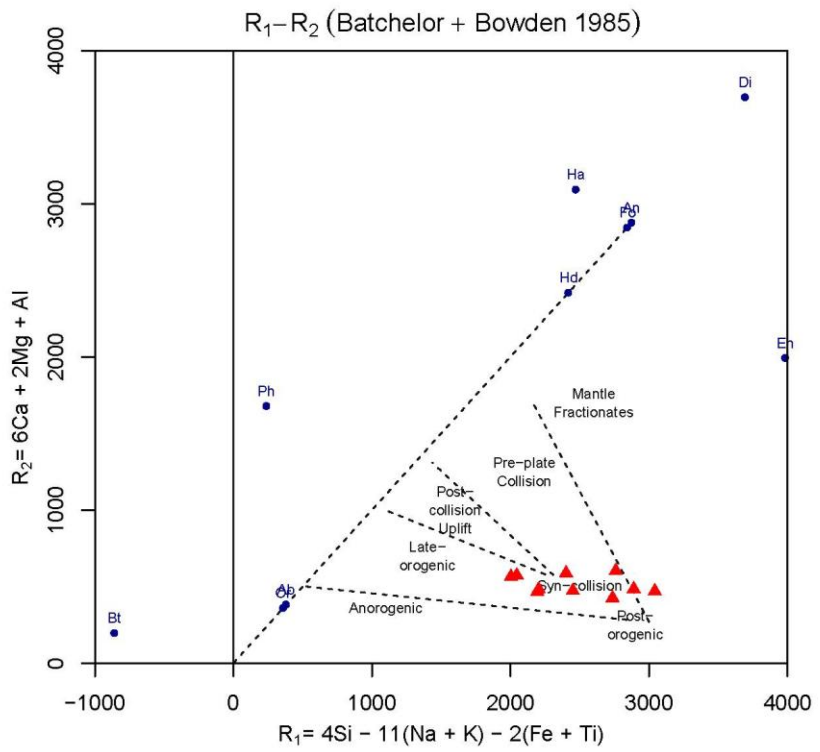

Figure 15: *Discriminant diagram of tectonic setting of R1-R2 (after Batchelor and Bowden, 1985)*

QAP diagram

Granitoids have different contents of quartz, alkali feldspar and plagioclase in different tectonic settings, which determine their particular positions in the QAP diagram. So, we can use QAP diagram to judge a granitoid's tectonic setting (Figure 16). In different tectonic settings, the corresponding rock type can be divided into different rock types. Here all the samples are of CEUG type is of A/P <2.0; alkali granite, alkali felds and quartz syenite. Figure shows that all plots fall into the CEUG area in the QAP diagram indicating that these granites are of Continental Epeiogenic Uplift Granites.

Pearce et al., (1984) emphasized that the fields on the discriminants diagrams strictly reflect source regions and melting (and crystallization histories) rather than tectonic regimes. It may be postulated the Bomdila granites were emplaced during period of crustal thickening. It is generally envisaged that during crustal thickening because of crustal overthrusting the volatiles, driven off the wet sedimentary wedges, may penetrate the hot overlying thrust sheet causing anatexis. This process is widely accepted for the generation of granites magmas at crustal levels (Harris et al., 1986; Fyfe, 1988; and Gopeshwar singh and Villinyagam, 2012).

Temperature and Pressure conditions

Bowen (1954) and Tuttle and Bowen (1958) concluded that there is a composition towards, which the liquids should migrate in the fractional crystallization of any material containing all the rock forming oxides; and they further concluded that the final liquid should have composition of almost equal proportion of quartz – albite – orthoclase. The normative albite, orthoclase and quartz of granites are plotted in the ternary diagram (Figure 17); fall in the minimum temperature trough in the system.

The normative values of Or, Ab and Qz of granites are plotted on Or – Ab – An and Qz – Ab – Or diagrams (Figure 18) (Yoder et al., 1967). An overall range of 650^{o}C to 700^{o} C and an average of 685^{o}C temperature for these granites are inferred.

In the ternary diagram of normative Qz – Or – Ab (Arth et al., 1978) all plots fall in between 5 to 7 kb of pressure (Figure 19). It is inferred that these granitic rocks are formed at 5 to 7 kb PH_2O and at 650^{o}C to 700^{o}C temperature.

The observed P –T ranges and the placement of the granites in the low temperature trough can be taken to indicate that the granites are of magmatic (whether juvenile or anatectic) origin. The older rocks had experienced granulite facies of metamorphism (Prasad et al., 1990), and the production of granite melt of expected in that environment. The low melting components of pelitic gneisses and other rocks of suitable composition may have led to the formation of granites.

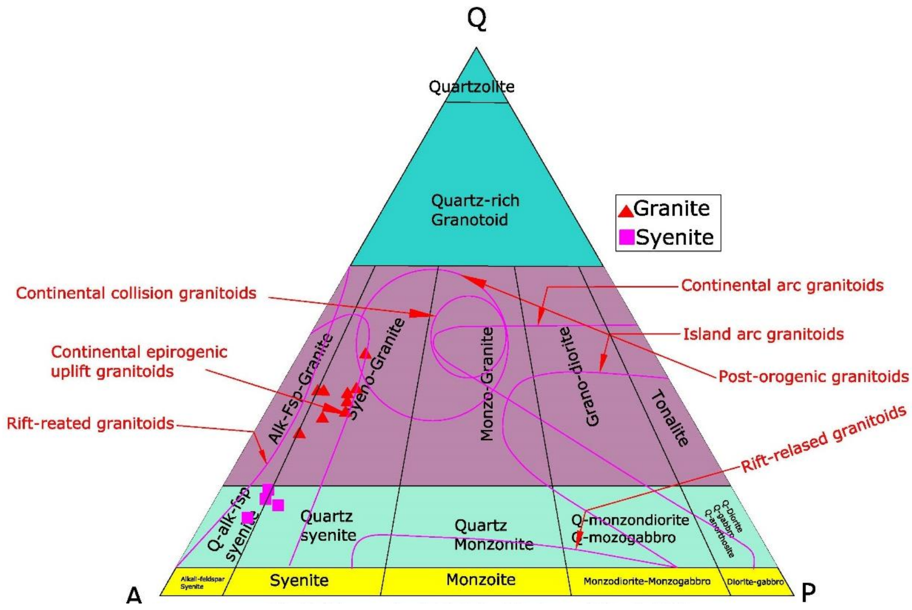

Figure 16: *Diagram for QAP (After Maniar and Piccoli, 1989)*

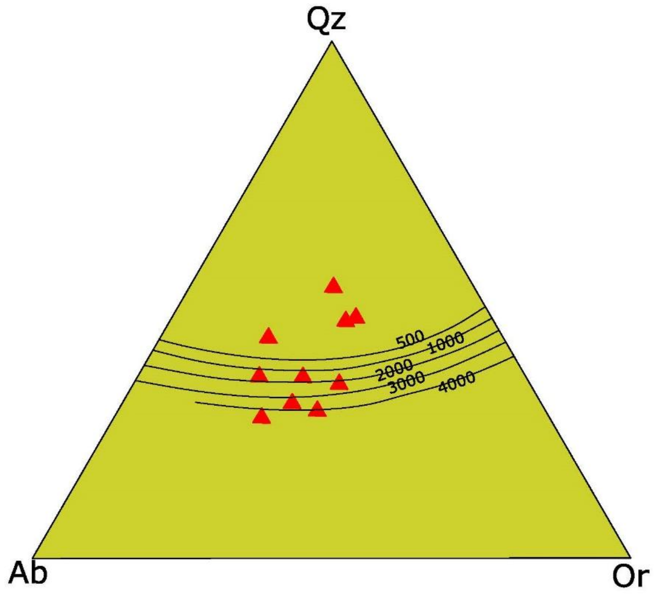

Figure 17: *Normative Quartz-Albite-Orthoclase diagram (after Bowen, 1958)*

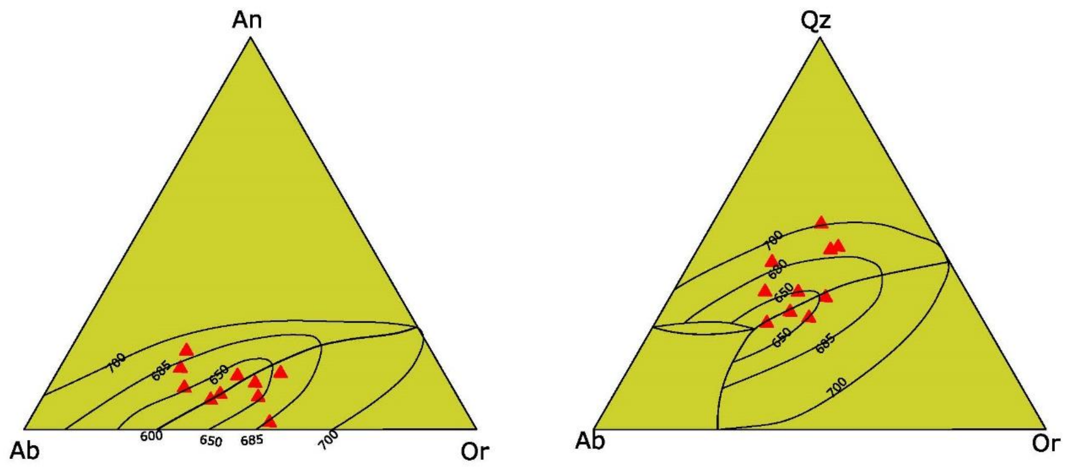

Figure 18: *a) Ab-An-Or; b) Qz-Ab-Or ternary diagrams (after Yoder et al., 1967)*

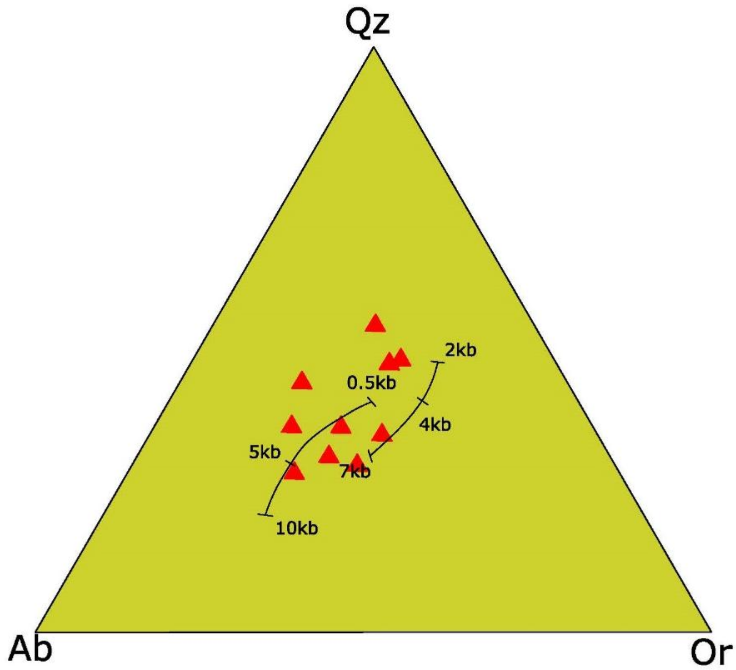

Figure 19: *Qz-Ab-Or ternary diagrams (after Arth et al., 1978)*

3. Conclusion

This study presents the geochemical characteristics of granites located in Obachettapalem in Prakasam district, A.P, forms that part of the Eastern Ghats which lies to the east of Cuddapah basin. Here in this work we discusses the possible petrogenetic process, source characteristics and its tectonic emplacement. These granites are associated with peletic gneisses and pyroxene granulates and charnackites. These granites are made up wholly of peraluminious alkali feldspar granites and are composed of quartz, K-feldspar, amphibole (hornblende), plagioclase, biotite and accessory minerals are ironoxieds, monazite, zircon, and apatite. Petrographically, they show cloudy, perthlitic texture and graphic texture. They are highly evolved magnessian, peraluminious and calc-alkaline type. These granites displaying typical geochemical characteristics with high SiO_2, Na_2O+K_2O, FeO*/MgO, REE (except Eu), Rb, Ba, Zr, depleted in MgO, CaO, Ta and Ce. Their trace and REE characteristics along with the use of various discrimination schemes revealed their correspondence to magmas derived from crustal origin. On the basis of geochemical data, we conclude that the granites are probably derived from a predominant crustal source with variable mantle involvement in a syn-collision setting, and crystallised at 650^{o}C to 700^{o}C at 5 to 7 kb of PH_2O.

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