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Petrological and Geochemical Studies on Granitoids in Bibinagar-Bhongir Area, Nalgonda District, Telangana, India.

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ABSTRACT
The Granitoids of the Bibinagar- Bhongir area in the Nalgonda district are purely high potassic calc alkaline and meta aluminous and A-type belongs to Peninsular Gneissic Complex of the Eastern Dharwar Craton. The petrographic study of granitoids indicates that of pure magmatic origin in the form of different magmatic textures viz. perthitic, porphyritic and poiklitic textures. Geochemically the granitoids are rich in K_2O & Na_2O suggesting source from calc-alkaline magma. The Granitoids are falling mostly in the volcanic arc field on Yb vs Ta discrimination plot. The REE pattern shows strong Eu negative anomaly, suggesting early separation of plagioclase and the enhanced level of LILE relative to HFSE in Bibinagar-Bhongir granitoids points to the subduction zone enrichment and/or crustal contamination of the source region.

***Key words*:** Granitoids, Geochemistry, Petrology,

I. INTRODUCTION

The Indian Peninsula is traditionally considered to be a monolithic continental shield constituted by crystalline rocks. Later, the Precambrian rocks of India were divided into distinct segments based on principal orogenic trend, viz. Dharwar, Eastern Ghat, Aravalli and Satpura. Several genetic classifications have been attempted reflecting divergent interpretation of the tectono-stratigraphic make-up of different parts of the peninsular shield – [A Manual of the Geology of India, Vol. 1, Pt. 1, Spl. Pub. No. 77, Geol. Surv. Ind., (2006)]. The basement and crust i.e. granites of the middle to late Archaean age are tonalite-trondhjemite-granodiorite (TTG) suites Swami Nath and Ramakrishnan (1981); Naqvi et al. (1983); Rama Rao and Divakara Rao (1994). The Closepet granite of the Indian sub-continent rich in potassic has been formed during the Archean to Paleoproterozoic Radhakrishna (1956); Friend (1984); Divakara Rao et al. (1999); Jayananda and Mahabaleswar (1992); Jayananda et al (1995). The middle to late Proterozoic granitic events are of local significance. The younger granite are meta-aluminous, alkali rich-calc-alkaline series, A- type and volcanic arc granites, syn-collision to late orogenic.

Geochemically the tectonic setting of granite can be inferred clearly through geochemistry. In this paper we describe the geology and geochemistry of a granitic rock of Peninsular Gneissic Complex.

The area under study forms a part of the Eastern Dharwar craton located within the state of Telangana. They area bounded by Latitudes 17.30 to 17.80 N; 78.60 to 79.00 E adjoining the Bibinagar-Bhongir of Nalgonda district [Fig 1(a, b)].

Fig-1a: Geology map of Telangana

Fig-1b: Geology map of Nalgonda, square showing study area.

II. GEOLOGICAL SETTING

Geology of the Dharwar craton has been synthesized and summarize by many pioneers viz., Swaminath and Radhakrishnan (1981); Naqvi (1981);

Radhakrishna (1983); Radhakrishna and Naqvi (1986); Naqvi and Rogers (1983,1987); Rogers (1996) Naqvi (2005) that the Dharwar Province is essentially a granite-greenstone terrain characterized by a number of NNW-SSE trending belts of schistose rocks separated by granitic terrains. The Province is divisible into western and eastern parts along a major shear zone west of the Closepet Granite [A Manual of the Geology of India, Vol. 1, Pt. 1, Spl. Pub. No. 77, Geol. Surv. Ind.,(2006)]. The Eastern Dharwar Craton (EDC) based on the lithological assemblage and its environment of emplacement or geodynamic setting is described an intra-oceanic [Manikyamba et al. (2004, 2005); Naqvi et al., (2006)]. The EDC comprised different type of granites. The state of Telangana geologically is located in the southeastern corner of the Precambrian shield.

III. PETROGRAPHY

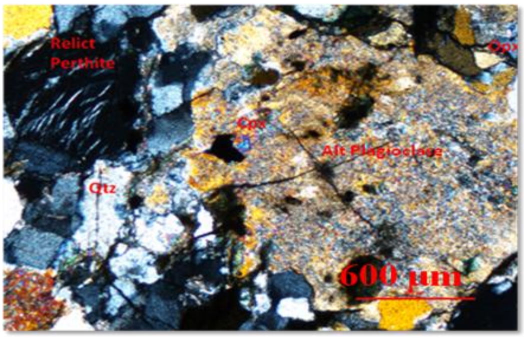
The Granitoid rocks of the Peninsular Gneissic Complex are generally massive, occasionally foliated and rarely gneissic. The rocks are leucocratic showing light grey to grayish pink in colour. The petrographic study of these rocks exhibit equigranular, coarse grained showing perthitic, porphyritic and poiklitic textures. The essential constituents are quartz, K-feldspar (orthoclase, microcline), plagioclase feldspar; minor amount of biotite, apatite and opaques. Microcline is predominant over orthoclase. The microcline phenocrysts have inclusions of quartz and twinned plagioclase with occasional alkali feldspar. The groundmass is composed of quartz, alkali feldspar, plagioclase and biotite with feldspars partially sericitised. The microcline grains at few places are perthitic, partially altered to chlorite observed at places. The plagioclase exhibits perthitic texture and the presence of primary biotite is an evidence for its magmatic source. Secondary muscovite is present as an alteration product of K-feldspar and chlorite. Most of the quartz grains exhibit undulose extinction. The K-feldspar is highly sericitised and contains perthitic lamellae and the contact of plagioclase and K-feldspar is myrmekitic in nature. Recrystallized biotite is present in minor amounts with zircon and opaque's as accessories. Recrystallized small quartz phenocryst grains are shows thin zoning. It is noticed that even the K-feldspar phenocrysts have been marginally recrystallized. Replacement of K-feldspar by the muscovite and chlorite is observed where the grain boundary is recrystallized.

Field photo-1: Epidote vein is intruded in to coarse grained pink granite at Hanumapur.

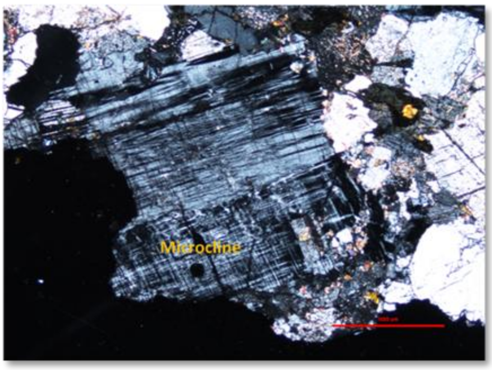
Field photo-2: Granite is intruded by quartz-pegmatite vein at SE Bhongir.

Field photo-3: Pegmatitic vein showing intrusive relationship with pink granite at Masireddipalli.

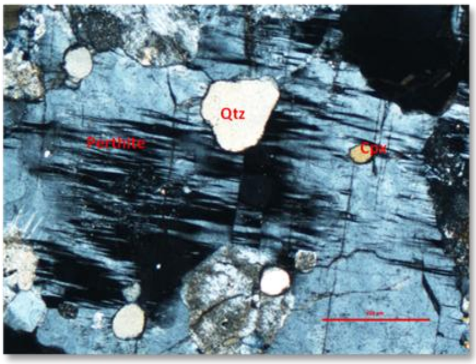
Field photo-4: Hornblende grains devoleped along foliation plane in granite at Kondamadugu.



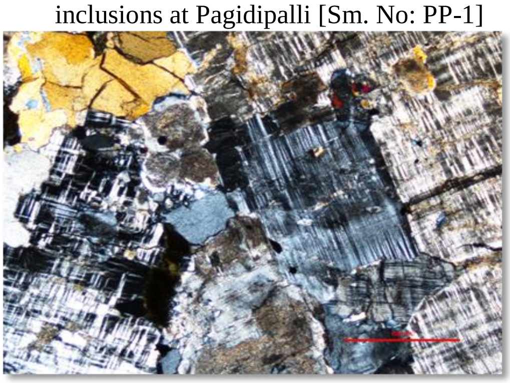
Photomicrograph-1: Granite showing altered alkali feldspar at Anjapur [Sample No AJ-1]



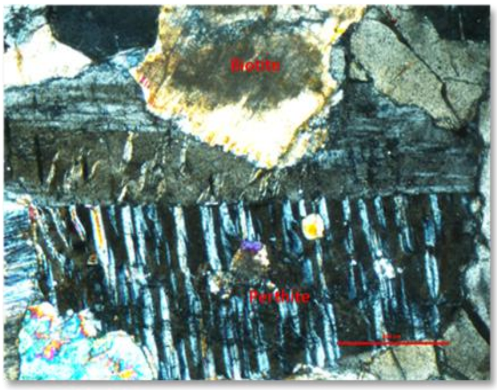
Photomicrograph-2: Microcline showing crosshatched twinning in Granite at Madhapuram [Sm. No: MA-1]



Photomicrograph-3: Perthite showing relict quartz inclusions at Pagidipalli [Sm. No: PP-1]



Photomicrograph-4: Microcline showing crosshatched twinning in Granite at Padamatisomaram [Sm. No PS-2]



Photomicrograph-5: Flame perthite in Granite at Padamatsomaram [Sm. No PS-2]

IV. SAMPLING AND ANALYTICAL TECHNIQUES

A total of 100 samples of granitoids from Bibinagar- Bhongir area in the Nalgonda district were collected. Around 40 thin sections were prepared and studied. Major oxides and trace element compositions were analyzed using X-ray fluorescence spectrometry (XRF) and Inductively Coupled Plasma-Mass Spectrometer (ICP-MS**)** at the National Geophysical Research Institute (NGRI), Hyderabad. The major oxides include SiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, K_2O, Na_2O, TiO_2 & P_2O_5 and the trace elements include Be, Ge, As, Mo, Hf, Ta, W, Bi, U, La, Ce, Pr, Nd, Eu, Sm, Tb, Gd, Dy, Ho, Er, Tm, Yb & Lu. The granites are plotted on an Ab-An-Or diagram of O'Connor, (1965) (Fig -2). The data falls within the granite field while few samples fall in the granodiorite field.

Harker diagram (Fig.-3) exhibits decrease in the amount of MgO, TiO_2, CaO, P_2O_5 and total Fe with increase in SiO_2.The negative correlation between SiO_2 vs CaO, SiO_2 vs TiO_2 and SiO_2 vs MgO indicating plagioclase fractionation as well as differential crystallisation and hence diorite-granodiorite and biotite granite are observed.

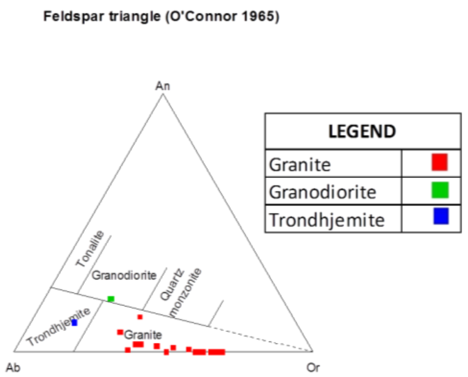


Fig-2: Granitoids plots in Feldspar triangles diagram (Ab-An-Or) after O'Connor 1965.

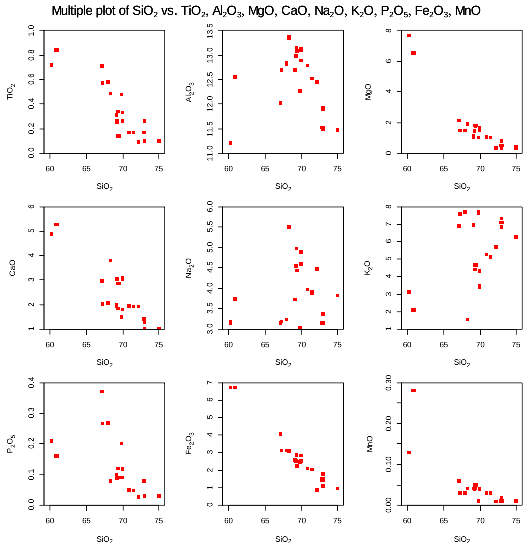


Fig.-3: Harker variation diagram of granitoids.

V. CLASSIFICATION/TECTONIC ENVIRONMENT

Classification of the rock with total alkali silica (TAS), SiO_2 vs K_2O+Na_2O geochemical rock classification diagram of Cox et al (1979) (Fig-4) adapted by Wilson, 1989 for plutonic rocks shows the plots fall mostly in the acid field or to be more specific mostly they falls in granite field and very few bordering diorite and syenite field. The solid curve line sub-dividing the alkaline from the subalkaline rocks. After plotting the TAS vs Silica (Fig-5) by Middlemost (1994) the plots are fall in granite field while few of them falls in quartz monzonite, granodiorite and diorite field. As per the K_2O+Na_2O; Fe_2O_3 and MgO plot (Fig-6) it is clear that the rock is rich in K_2O+Na_2O which means it is alkali granite. The AFM plot (Fig-7) after Irvine and Baragar (1971) suggests the magma to be Calc-alkaline in nature. When the major Oxides data were plotted (Fig-8) in the R1-R2 diagram of De La Roche et al (1980) which is based upon the cation proportions expressed as millications on an X-Y bivariate graph using the plotting parameters R1& R2 where R1 is plotted along the X-axis and is defined by R1=4Si-11(Na+K)-2(Fe+Ti) and Fe represents the total Fe while the R2 is plotted along the Y-axis and is defined as R2=(Al+2Mg+6Ca), the plots fall in the granite, granodiorite, quartz monzonite, alkali granite and diorite field. The Molar Na_2O-Al_2O_3-K_2O plot (Fig-9) shows granitoids are meta-aluminous, alkali rich-calc-alkaline series. Numerous petrogenetic schemes such as Whalen et al. (1987) and Pearce et al. (1984) have been proposed for the origin of the chemically distinctive A-type (Anorogenic Granites). Whalen et al. (1987) has used a factor (10000*Ga/Al) plotted against elements like Nb, Ce, Zr, Y, Zn, (K_2O+Na_2O), and against ratios K_2O/MgO, FeOt /MgO, (K_2O+Na_2O)/CaO to show discrimination of A-type granite from the general M-, I- and S-type granites. Similarly, he used (Zr+Ce+Y+Nb) against FeOt /MgO and (K_2O+Na_2O)/CaO to distinguish A-type granite (Fig-10) falls in A- type and volcanic arc granites, syn-collision to late orogenic.

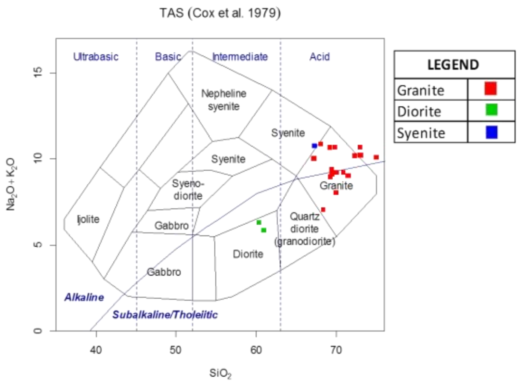


Fig-4: SiO_2 vs Na_2O+K_2O binary (TAS, Cox et al.1979) diagram shows majority of samples fall in Granitic field except two of them falls in diorite field.

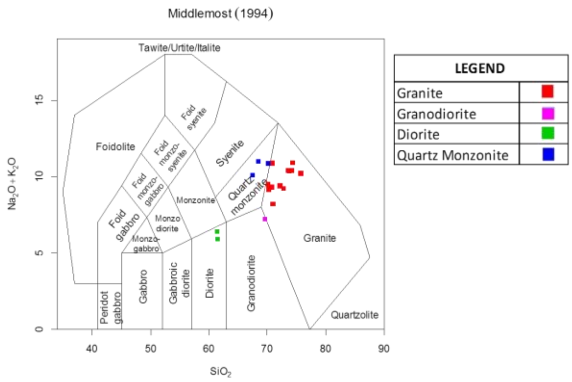


Fig-5: Na_2O+K_2O vs SiO_2 binary (Middlemost, 1994) diagram shows Plots of Granitoids of Bibinagar-Bhongir area.

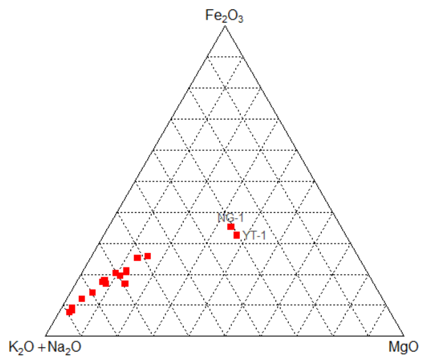


Fig-6: $Na_2O + K_2O$, Fe2O3 and MgO plot

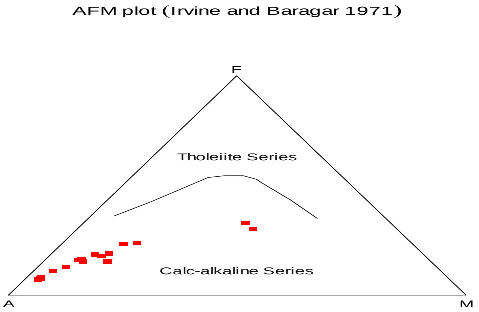


Fig-7: AFM triangular diagram for Granitoids after Irvine and Baragar (1971). A = Wt% $Na_2O + K_2O$, F = Wt% $FeO+Fe_2O_3$ and M = Wt% MgO recalculated to 100

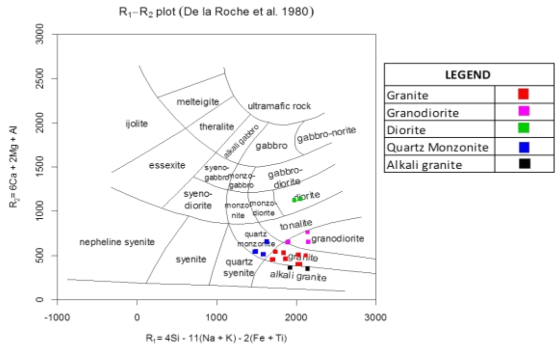


Fig-8: R1-R2 plot (De la Roche et al. 1980) of granitoids of Bibinagar-Bhongir area.

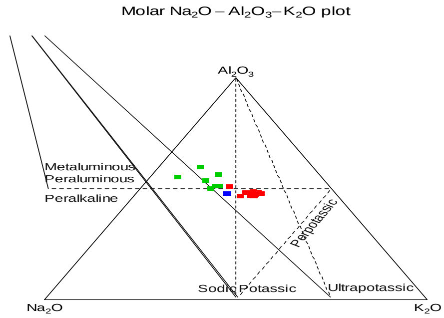


Fig-9: Molar Na_2O- Al_2O_3- K_2O plot.

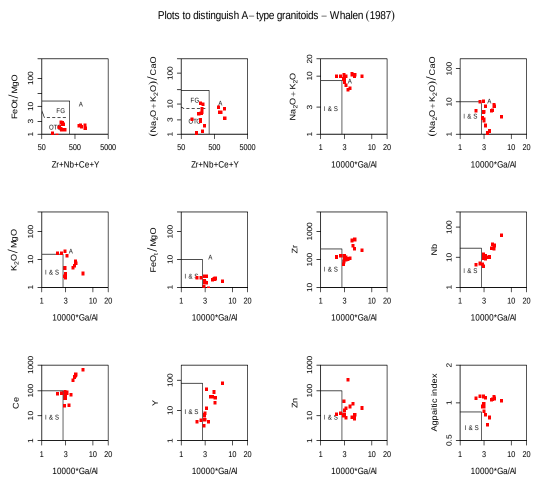


Fig-10: Granitoids indicating a type nature (Whalen, 1987)

When the granite data was plotted on a Ta vs Yb diagram (Fig-11) using the composition and discriminate fields of Pearce et al (1984) they fell in the Volcanic Arc Granite field and few plots in the syn-collision granite field.

The same data i.e. K_2O-Fe_2O_3 vs SiO_2 and Fe_2O_3 vs MgO (Fig -12) plotted in Maniar and Piccoli (1989) which is primarily a major element based on geotectonic classification, it occupied the Island Arc Granite(IAG) + Continental Arc Granite (CAG) + Continental Collision Granite (CCG).

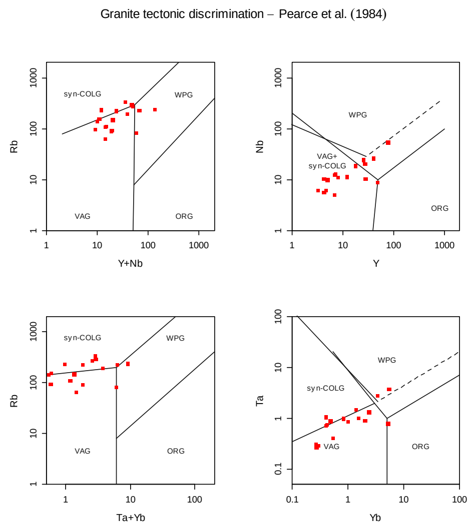


Fig-11: Granite tectonic decimation –Pearce et al. (1984)

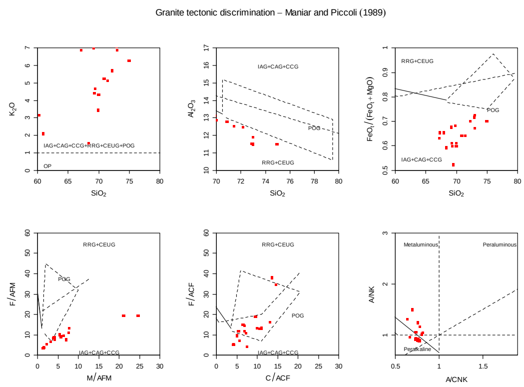


Fig-12: Granite tectonic discrimination- Maniar and Piccoli (1989).

VI. RARE EARTH ELEMENTS (REE)

The REE pattern of the igneous rock is controlled by the REE chemistry of its source and the crystal melt equilibrium which has taken place during its evaluation. The characteristic chondrite normalized REE pattern of granite (Fig -13) shows strong negative Eu anomaly suggesting early separation of plagioclase by Nakamura (1974).

On a spider diagram multi element profiles normalised to primitive mantle as per Sun & Macdonough (1989) the Bibinagar-Bhongir granitoids (Fig -14) patterns showing volcanic arc granite such as the rocks in the region are enriched with large ion lithophile elements (LILE) such as Th, Ba and Rb with a high ionic strength or high field strength elements (HFSE) such as Ti, Y and P show depletion, which is the characteristic of volcanic arc granites. The enrichment of Ce and La in Calc-alkaline and Shonshonitic Series and low value of Y and Yb relative to the normalizing composition indicates the volcanic arc granites. The enhanced level of LILE relative to HFSE in Bibinagar-Bhongir granitoids (Fig-11) points to the subduction zone enrichment and/or crustal contamination of the source region as per Pearce et al (1984). The patterns indicate moderately fractionated LREE and poorly fractionated HREE (Fig- 14).

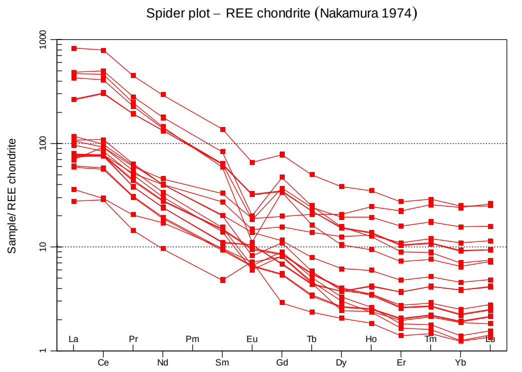


Fig-13: Nakamura, N., (1974) Determination of REE.

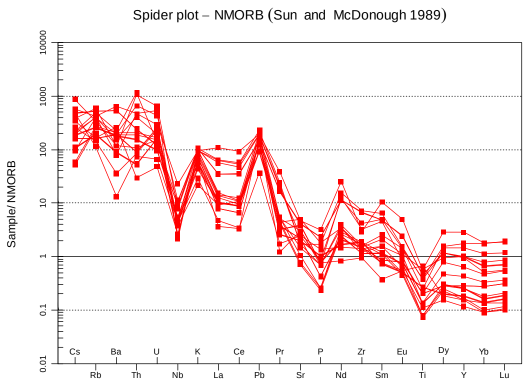


Fig-14: Sun, S.S., McDonough, W.F., (1989).

VII. SUMMARY AND CONCLUSIONS

The petrographic study of Granitoids of the Bibinagar- Bhongir area are indicates that of pure magmatic origin in the form of different magmatic textures viz. perthitic, porphyritic, poiklitic textures and presence of many fresh quartz grains. The Granitoids are also showing syntectonic movement. The field evidences viz., the alignment of hornblende along foliation plane, enrichment of biotite at places and migmatisation of magma is evidenced. It was evidenced by petrographic studies also such as, the bent twin lamellae of plagioclase which was developed due to deformation and recrystallisation of quartz grains.

The granites plotted on an Ab-An-Or diagram (Fig-2) O'Connor, 1965) is falls within the granite field. Based on classification of the rock with total alkali silica (TAS), SiO_2 vs K_2O+Na_2O geochemical rock classification diagram of Cox et al (1979) (Fig -4), adapted by Wilson,1989 for plutonic rocks, mostly they fall in granite field and very few bordering the diorite and syenite field. The TAS vs Silica (Fig-5) by Middlemost (1994) plot falls in the granite field while few are falling in the granodiorite, quartzmonzonite and diorite field.

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The same data i.e. K_2O-Fe_2O_3 vs SiO_2 and Fe_2O_3 vs MgO (Fig -12) plotted in Maniar and Piccoli (1989) which is primarily a major element based on geotectonic classification, it occupied the Island Arc Granite(IAG) + Continental Arc Granite (CAG) + Continental Collision Granite (CCG).

The characteristic chondrite normalized REE pattern of granite (Fig -13) shows strong negative Eu anomaly suggesting early separation of plagioclase by Nakamura (1974). The enrichment of Ce and La in Calc-alkaline and Shonshonitic Series and low value of Y and Yb relative to the normalizing composition indicates the volcanic arc granites. The enhanced level of LILE relative to HFSE in Bibinagar-Bhongir granitoids (Fig-11) points to the subduction zone enrichment and/or crustal contamination of the source region as per Pearce et al (1984).

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