



Petrography and Geochemistry of the Monzogranites from SE part of Dharmaram, Peddapalli District, Eastern Dharwar Craton, South India.

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Abstract: This paper presents the petrology and geochemistry of SE part of Dharmaram granites which occur near to Karimnagar Granulite belt area, NE of Karimnagar district of Telangana State within Eastern Dharwar Craton (EDC). Geologically, the study area is dominated by granitic rocks of Precambrian age. The lithological variants in the study area mostly covered by pink granites, gneissic grey granites, coarse-grained pegmatite veins, quartz veins and epidote veins are observed as cross-cutting or parallel to the granitoids and are sometimes folded and deformed. The monzogranite is megascopically medium to coarse grained, inequigranular, porphyritic in texture and composed of K-feldspar (microcline perthite; 25-36% by volume), quartz (27-31%) and plagioclase (31-39%) in the order of decreasing abundance. Mafic minerals include biotite (2-8 %) and magnetite, titanite, zircon and apatite are accessory phases. Presence of discrete plagioclase grains in substantial proportions suggests sub-solvus crystallisation of the parental magma. Geochemically monzogranite are having high SiO₂ (69-73 wt. %), high K₂O (4-6wt. %) and low Na₂O (3 wt.%). The chondrite normalised REE patterns of monzogranite display LREE-enriched and HREE-depleted patterns with negative Eu anomaly. The monzogranites show high LREE/HREE ratio that hints at either fractional crystallisation or an LILE-enriched source. The negative Eu anomaly indicates the role of feldspar in the genesis of the monzogranites. And one sample shows positive europium anomaly indicate role plagioclase in equilibrium conditions.

Keywords: Granite, TTG, dolerite dyke, pegmatite quartz vein, Dharwar craton, Dharmaram.

1.INTRODUCTION

Granitic rocks, unique to the planet Earth, provide vital clues on the formation and evolution of the continental crust (Cawood et al., 2013). Formation of granitic rocks can occur by two different mechanisms, i.e., melting and differentiation of basaltic rock and/or by the melting of the pre-existing crustal rocks (Moyen et al., 2017). The transition from a stagnant lid tectonic regime to present-day plate tectonics is believed to have initiated by 3.0 Ga and became prominent by the end of the Archean (Dhuime et al., 2012; Keller and Schoene, 2012). The global transition in the nature and style of plate tectonic processes is well-reflected and resulted in the compositional diversification of the Neoproterozoic granitoids (Moyen et al., 2003; Laurent et al., 2014). Based on the source and petrogenetic mechanism, the Neoproterozoic granitoids have been classified into Tonalite Trondhjemite Granodiorites (TTGs), sanukitoids, biotite and two-mica granites and hybrid granites (Laurent et al., 2014). The TTGs are sourced from the partial melting of meta basalts, sanukitoids are derived from an enriched mantle, and the biotite and two-mica granites are purely crustal-derived. The hybrid granites are formed by variable interaction between the three above-mentioned granitic melts (Laurent et al., 2014). The Dharwar craton of southern India contains a considerable volume of granitic rocks. The western and eastern segments of the

Dharwar craton display distinctly different phases of granite emplacement. The 3.35-3.3 Ga poly-phase tonalite-trondhjemite granodiorite (TTG) suites are dominate with in the western Dharwar craton (WDC) compared to the 2.7-2.5 Ga calc-alkaline granitic rocks of the eastern Dharwar craton (EDC) where some older remnant granites are preserved (3.3–3.0 Ga) (Meen et al. 1992; Jayananda et al. 2020). Two major episodic events in the EDC include large volcanic-dominated greenstone belts at 2.7 – 2.54 Ga (Manikyamba et al. 2009; Manikyamba and Kerrich, 2012) and extensive North-South trending calc-alkaline plutonic bodies at 2.57-2.52 Ga (Dey 2013; Jayananda et al. 2013). The Karimnagar granulite belt (KGB) from EDC accommodates several smaller granitic plutons that run along the NW- SE trending Pranahita-Godavari rift basin. The KGB usually consists of granite gneisses associated with charnockite, enderbite, banded magnetite quartzite (BMQ), and dolerite dykes (Rajesham et al. 1993; Meshram et al. 2021). The granites from SE part of Dharmavaram area distributed in isolated areas have also been correlated by Dharmaram area granites. In continuation of that, the present investigation deals with petrographic characteristics and geochemistry of SE part of Dharmaram Granite, located in the area of Peddapalli district. The present study aims at elucidating their field, petrography and geochemical data which is vital to characterize these rocks and to discuss thier petrogenesis so as to link to the tectonic evolution of EDC.

2.FIELD SETUP

The study area SE part of Dharmaram area occupies the Northern part of Eastern Dharwar Craton (EDC) (Fig.1.A). The area is bounded by between Latitude 18°45'-18°48'N and 79°10'- 79°09'E Longitudes. It forms a part of Survey of India Toposheet Nos 56 N/6(E44H6) and 56N/2(E44H2) and covers an 180 sq km. The area mainly comprises of granitoids of Precambrian age which forms a part of the unclassified crystalline rocks of Peninsular Gneissic Complex (PGC). The outcrops include a variety of pink granites, gneissic grey granites, coarse-grained pegmatite veins, quartz veins and epidote veins are observed as cross-cutting or parallel to the granitoids and are sometimes folded and deformed. Dolerite dykes (Fig.1.B) are cross-cutting the granitoids. The dykes strike in different directions and are seen as persistent linear ridges extending for several kilometres with varying width.

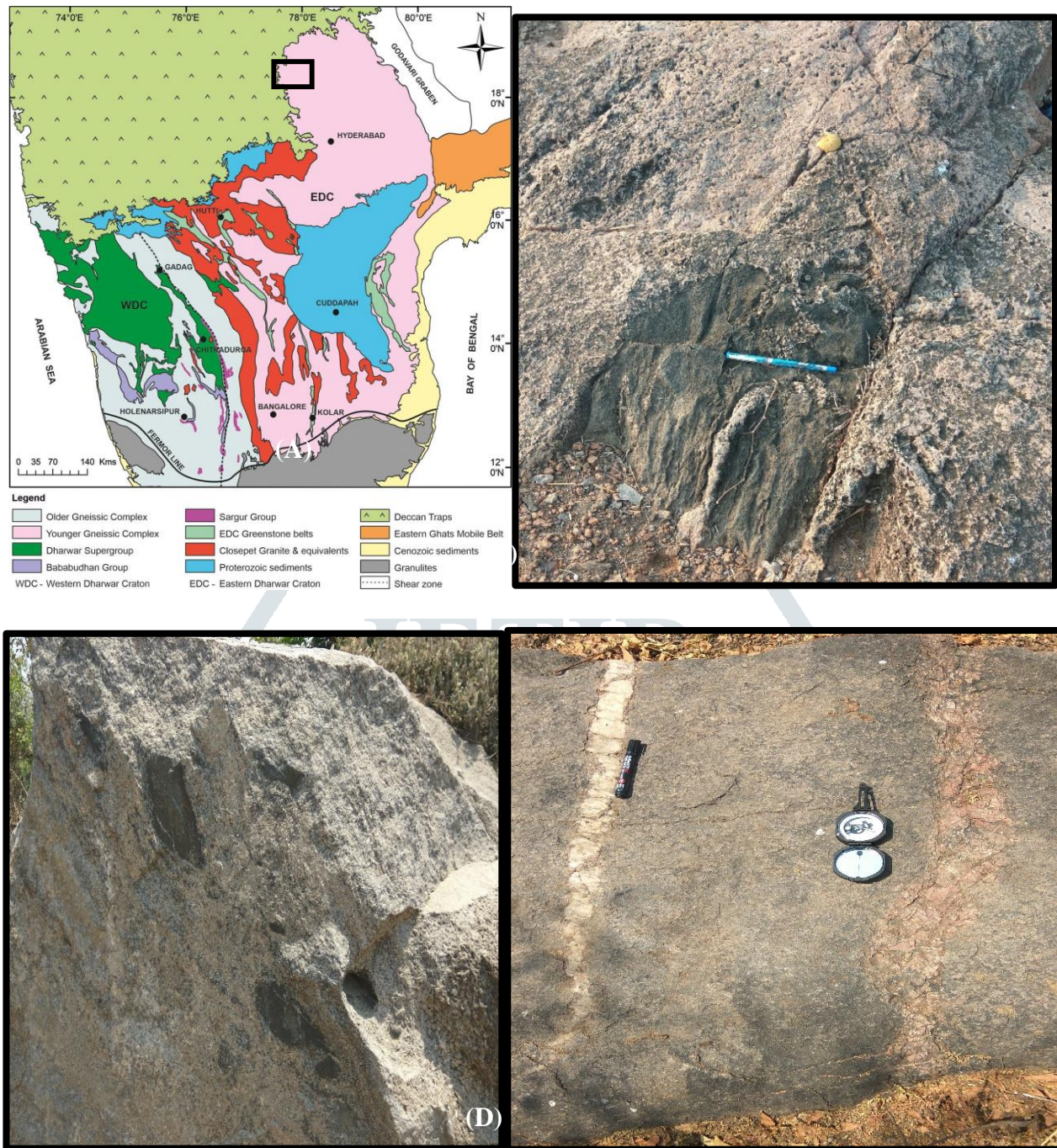


Fig.1. A) Generalised geological map of Dharwar Craton, southern India (after GSI 1994). B) Dolerite dyke with in the grey granite, C) Enclaves are noticed with in the granite, D) Pegmatite and quartz veins are noticed in granite.

3. ANALYTICAL METHODS

Approximately 20 fresh representative samples without alteration and weathering rinds were collected from field. Out of which three samples were selected for making thin polished sections to observed minerals under petrological microscope. And also three samples were selected for crushing, powdering for major, trace and REE elements analyzed at the National Geophysical Research Institute in Hyderabad, a Philips Magi PRO model (PW 2440) wavelength dispersive X-ray fluorescence spectrometer coupled with an automatic sample changer (PW 2540) was used to analyze the data. The trace and REE content of granite samples is determined using a 0.1% solution prepared using HF-HCl-HNO₃ acid decomposing procedures and analyzed using a Perkin

Elmer Scitex ELAN DRC II ICP-MS at the National Geophysical Research Institute in Hyderabad. Fine powders (0.075 mm) of rock samples and matrix were prepared, along with corresponding international reference standards from the Geological Survey of Japan, such as G-2, NIM-G, GS-N, and JG-1a for granites, were considered for the analysis.

4. PETROGRAPHY

Megascopically the monzogranites are leucocratic to mesocratic in colour, medium to coarse grained, inequigranular and occasionally shows porphyritic texture are observed with a naked eye (Fig.2A). And also, optically these samples show clearly hypidiomorphic texture (Fig.2B), holocrystalline and medium to coarse in nature. The major minerals contain quartz, k-feldspar, plagioclase and less of biotite. Accessory minerals are zircon, apatite, calcite, monazite and opaques (magnetite and pyrite). Quartz is medium to coarse-grained, irregular, and exhibits wavy extinction. Anhedral quartz grains have been observed to form in the form of intergrowth with orthoclase and plagioclase. At places quartz is shows recrystallized nature that indicating low degree of deformation. The plagioclase feldspars and k-feldspar are equal in amount in the studied rock. Feldspars are medium to coarse grained with subhedral to anhedral exhibits lamellar and cross hatched twinning. Some of feldspars are devoid of twinning due to stress effect. The feldspar are shows strong sericitization effect along the twin lamellae of plagioclase that indicate low degree of brittle deformation under low temperature conditions. The two types feldspars are noticed in these granites shows sub solvus crystallization of parental magma to form intergrowth textures like perthite (Fig.2F) and myrmekitic (Fig.2C) between plagioclase and k-feldspar with associated with quartz. Biotite and pyroxenes are essential ferromagnesium minerals are noticed in the studies rock samples. Zircon and apatite are major accessory minerals in these granites. Zircon are medium to very fine size, subhedral to euhedral, high relief and higher order interference colours are observed. Zircon Patchy dull interference colours to indicate radioactive nature (Fig.2D). Secondary minerals like epidote is noticed with in the monzogranite (Fig.2E). In the QAP diagram (Streckeisen, 1967) the rocks fall in the fields of monzo granite (Fig. 3A)

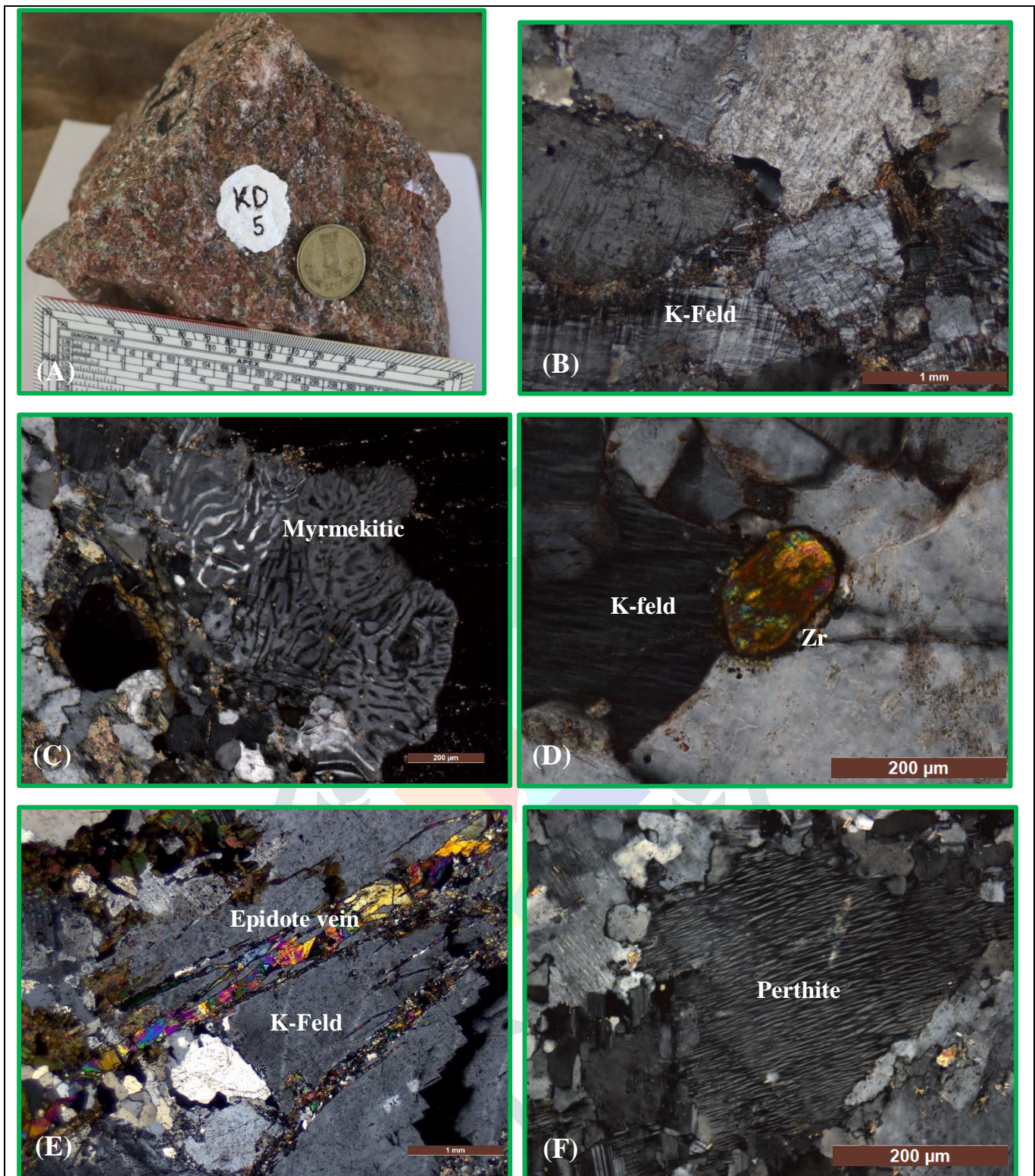


Fig.2. Microscopic features of Monzogranites A) Megascopic of monzogranite, B) This microphotograph clearly displays hypidiomorphic granular texture, C) Myrmekitic texture developed between quartz and plagioclase, D) Radioactive Zircon show patchy and ferruginous coating, E) Epidote veins with in the monzogranite F) Perthite Texture.

5. GEOCHEMISTRY:

The monzogranites are enriched in SiO_2 , Al_2O_3 and total alkalis especially K_2O over Na_2O , and depleted in MnO , MgO , CaO , Fe_2O_3 , TiO_2 , and P_2O_5 (Table 1.). In the normative feldspar triangular of O' Connor 1965,

all the rocks fall in the granite field except one sample being shown the quartz monzodiorite composition (Figure.3b). However, in the AFM diagram (Irvine and Baragar, 1971), the studied granites plot within the calc-alkaline field and progress towards the total alkalis domain (Figure 4a). The A/NK versus A/CNK diagram (Shand, 1943) establishes the metaluminous to peraluminous nature of Dharmaram monzogranites (Figure 4b). In the total alkali-silica (TAS) diagram (Figure 5; Cox et al., 1979) all the studied rocks are fall in granitic field, spanning the sub alkaline and alkaline fields.

Table.1. Major element oxide and trace element data (wt%) of SE part of Dharmaram and Dharmaram area.

	SE of Dharmaram			Dharmavaram				
S. No	1	2	3	4	5	6	7	8
Sample No	KD-5	KD-2	MD-3	PG-1	PG-2	PG-3	PG-4	PG-5
SiO ₂	71.84	73.41	69.84	75.12	69.2	69.34	73.48	75.48
Al ₂ O ₃	14.94	12.99	14.89	11.82	13.08	13.74	11.62	9.31
Fe ₂ O ₃	1.08	1.87	2.37	0.82	2.12	3.75	0.91	0.88
MnO	0.01	0.01	0.02	0.03	0.05	0.05	0.02	0.02
MgO	0.50	0.34	0.96	0.78	0.72	1.15	0.68	0.6
CaO	1.23	1.20	2.13	1.5	2.36	1.62	1.41	1.36
Na ₂ O	3.05	3.34	3.50	3.2	2	2.9	2.9	1.9
K ₂ O	6.19	5.20	4.33	5.2	5.3	4.2	5.2	4.5
TiO ₂	0.07	0.12	0.21	0.28	0.26	0.4	0.28	0.43
FeO	0.97	1.69	2.13	1.43	1.43	1.25	1.25	1.79
V	11.20	13.09	37.97	25.00	56.00	22.00	24.00	27.00
Cr	94.10	120.64	89.03	174.00	135.00	176.00	173.00	169.00
Co	2.93	1.95	5.55	10.00	8.50	8.00	9.20	9.50
Ni	4.36	3.52	4.07	13.00	11.00	20.00	11.00	21.00
Cu	8.43	6.31	7.14	10.00	5.00	11.00	10.00	12.00
Ga	15.41	14.56	14.41	15.00	23.00	15.00	16.00	17.00
Rb	117.37	86.52	81.29	190.00	170.00	210.00	170.00	130.00
Sr	181.23	123.73	546.25	200.00	590.00	220.00	200.00	120.00
Y	5.63	4.41	4.74	78.00	51.00	85.00	55.00	55.00
Zr	170.13	207.40	237.02	243.00	232.00	180.00	176.00	315.00
Nb	0.88	1.64	3.06	21.00	10.00	21.00	15.00	21.00
Cs	0.24	0.20	0.32	1.50	1.70	1.70	<1	1.40
Ba	692.08	407.96	2974.83	730.00	800.00	1130.00	660.00	530.00
Hf	4.67	6.05	6.02	60.00	7.00	12.00	57.00	16.80
Ta	0.08	0.11	0.21	3.80	2.60	2.90	3.90	3.00
Pb	57.97	43.09	19.45	45.00	57.00	44.00	40.00	41.00
Th	92.40	74.87	3.98	102.00	76.00	72.00	146.00	62.00
U	2.56	2.81	0.89	13.00	4.50	4.00	18.00	6.00
La	135.60	121.15	25.41	218.00	104.00	78.00	245.00	142.00
Ce	214.48	194.63	36.51	430.00	184.00	135.00	523.00	266.00
Nd	64.39	58.96	12.00	182.00	83.00	65.00	205.00	117.00
Sm	12.16	11.06	2.48	28.00	14.00	10.50	30.00	18.50
Eu	1.43	1.45	1.71	3.00	2.00	1.60	3.20	2.40
Tb	0.41	0.35	0.17	2.80	1.40	1.00	3.00	1.90
Tm	0.06	0.05	0.07	1.60	0.70	0.70	1.80	1.20
Yb	0.35	0.31	0.44	10.00	4.80	4.00	11.40	7.00
Lu	0.06	0.05	0.07	1.40	0.65	0.60	1.60	1.10

Note: S.No.1-3 Present study samples, 4-8 Dharmaram area granites

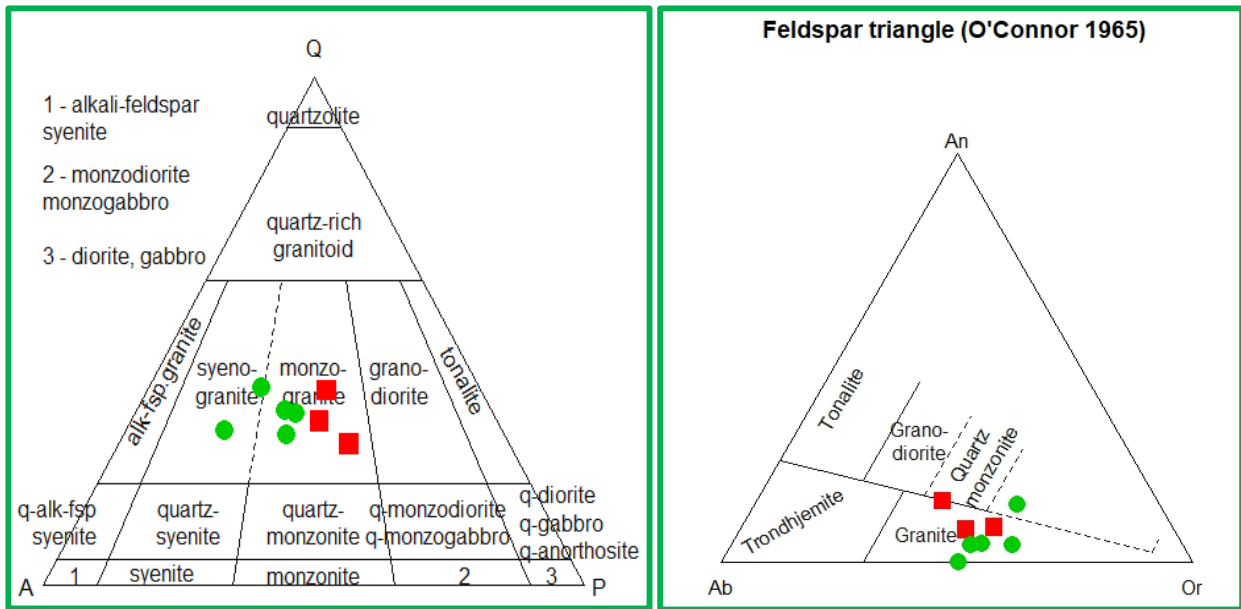


Fig. 3. (a) Plots of granites of the SE part of Dharmaram and Dharmaram area in the QAP 'modal' diagram (Streckeisen, 1967) and (b) 'normative' feldspar triangle (O'Connor, 1965) Symbols: Red square SE part of Dharmaram granites (Present Study) and green colour circles Dharmaram granites

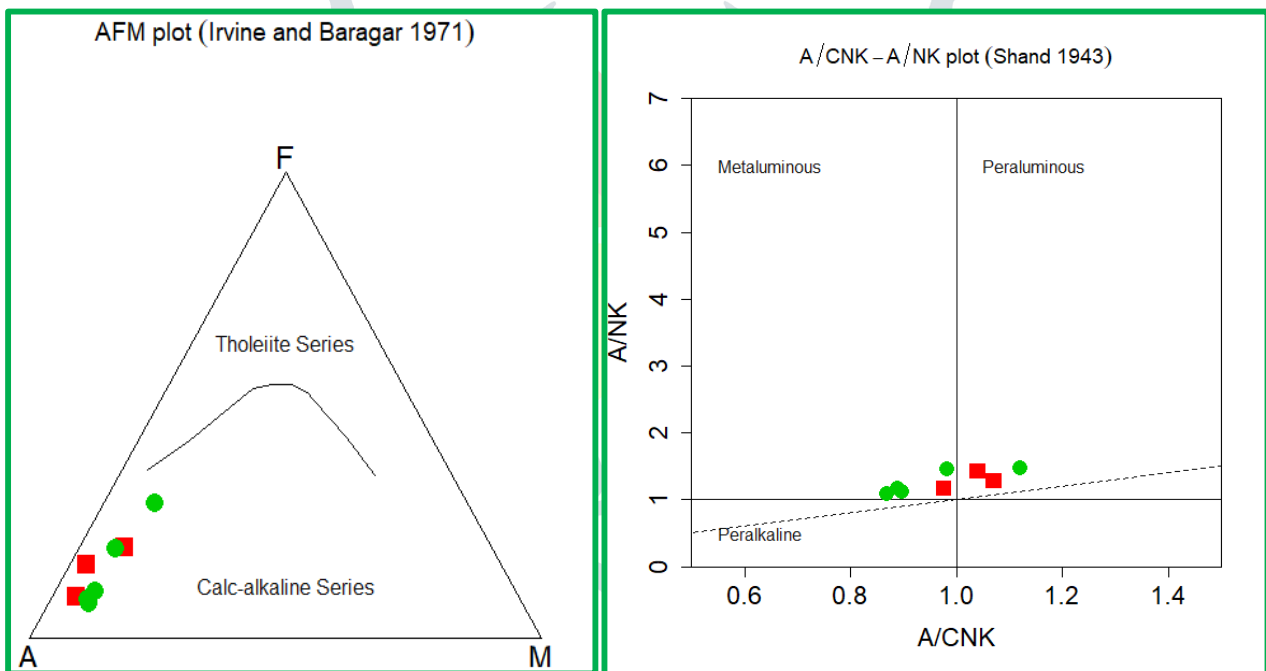


Fig. 4. (a) AFM diagram showing the calc alkaline nature. and (b) A/NK vs A/CNK diagram for Dharmaram area depicting the metaluminous nature to peraluminous nature. Symbols same as Fig. 3a

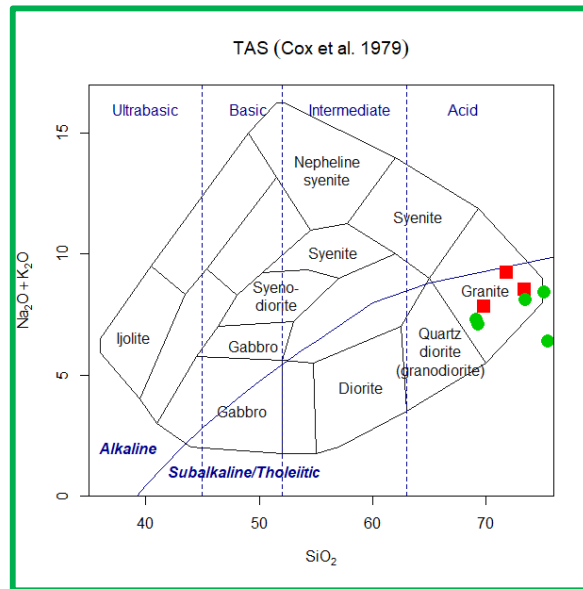


Fig.5. Plots of granite samples of Dharmaram TAS diagram (Cox et al, 1979) Symbols same as Fig. 3a

6. Tectonic affinity

The evaluation of tectonic affinity of the granitic magmas can be effectively studied using widely accepted major oxide and trace element based tectonic discrimination diagrams through time (e.g., Pearce et al., 1984; Batchelor and Bowden, 1985; Harris et al., 1986; Sylvester, 1989; Frost et al., 2001). Among the several tectano magmatic discrimination diagrams available, much emphasis was given to Pearce et al., 1984 due to their wide applicability. In the Pearce et al., 1984 diagram all the SE part Dharmaram monzogranites are plotted in the collisional/volcanic arc granitic fields and the Dharmaram area granites are fall within the within plate granitic field (Fig.6) indicating magmatic arc setting. The chondrite normalised REE patterns of monzogranite display LREE-enriched and HREE-depleted patterns with negative Eu anomaly and one sample shows positive Eu anomaly in SE part Dharmaram granites and the Dharmaram granites show negative Eu anomaly. The monzogranites show high LREE/HREE ratio that hints at either fractional crystallisation or an LILE-enriched source. The negative Eu anomaly indicates the role of feldspar in the genesis of the monzogranites and positive anomaly shows plagioclase in equilibrium conditions (Fig.7.).

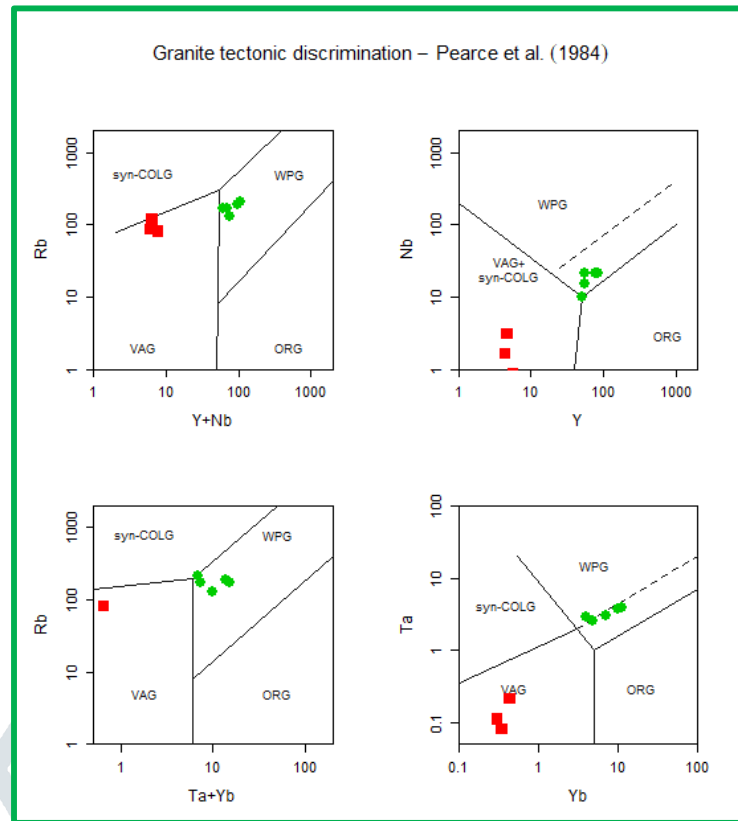


Fig.6. Tectonic discrimination diagrams, showing the tectonic setting of Dharmaram granites. Symbols same as Fig. 3a

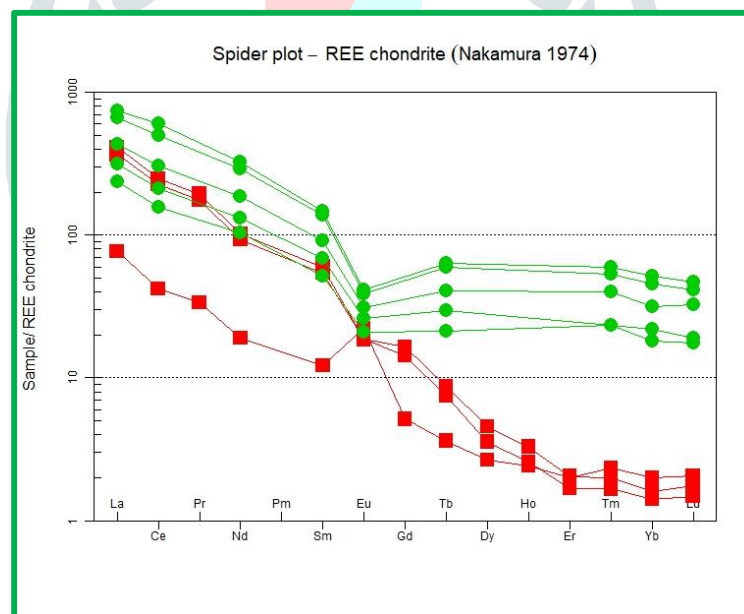


Fig.7. Chondrite normalized REE plots multi-element spider diagram (Nakamura 1974) for the granites of Dharmaram. Symbols same as Fig. 3a

7. CONCLUSION:

Detailed field, petrographic and geochemical studies of the granitoids around Dharmaram area from Peddapalli district of EDC, indicate that the rocks fall in the granite field in IUGS QAP diagram. Geochemical characters indicate calc alkaline nature. Trace element tectonic discrimination studies of the granites of Dharmaram area indicate their emplacement in volcanic arc granite to syn-collisional granite setting and the Dharmaram area granites shows with in plate granites.

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