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Petrography and Geochemistry of the Hindupur Granites, northern part of Eastern Dharwar Craton, south India

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Abstract - Granitic suite of rocks corresponding to acidic magmatism from Hindupur areas of Narayanapet district of Telangana, a part of Eastern Dharwar Craton of stable Peninsular Indian shield are described. The area exposes different types of granitic rocks of Dharwar Supergroup which were grouped under Peninsular Gneissic Complex (PGC). The rocks of PGC and Dharwar super group are intruded by younger granitoids of Tonalite-Trondhjemite-Granodiorite composition invariably intruded by dolerite dykes. An area of around 120 km2 covering Hindupur areas (77°15'E-77°30'E and 16°30'N-16°22'N) has been taken up for detailed investigations. Many varieties like granite, pink granite, gray granite, gneissic and banded magmatic (pink) alternate felsic and mafic rocks, biotite rich granite, and other rock types including dolerite dykes, quartz veins and pegmatite veins are noticed during systematic field traverses and the resultant findings are presented herein.

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

I. INTRODUCTION

Granitoid rocks are ubiquitous in stable Archaean cratonic parts of the world and also present as intrusions in post-Archaean eras. Geochemistry of granitic suite of rocks corresponding to acidic magmatism from Maganuru and Gudabelluru areas within the northern part of Eastern Dharwar Craton (EDC) are described as granitic rocks occupy a substantial portion of the continental areas particularly the Precambrian shields and also the Phanerozoic orogenic belts. The granitoid rocks also occur in cratonic areas of other continents. However, their abundance in oceanic setting is limited [20]. Granitoids of late Archean (~2.7 to 2.5 Ga) are Na and Ca rich Tonalite-Trondhjemite-Granodiorites (TTGs) and high-Mg diorite suite. The TTGs are silica and alumina rich, large voluminous bodies occurred due to basalt partial melting [1]. The Mg rich diorites are silica poor, diorite to granodiorite in compositions, formed typically from the melts derived from mantle rocks. The Eastern Dharwar Craton (EDC) largely consists of these late Archaean granitic intrusions into older TTG gneisses, greenstone belts and calc-alkaline rocks [6]. The granites from Mahabubnagar, Medak and districts distributed in isolated areas have also been correlated by [20] [21]. In continuation of that, the present investigation deals with petrographic characteristics and geochemistry of Hindupur Granite (HG), located in the Maganuru area of Narayanpet. 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 the tectonic evolution of EDC.

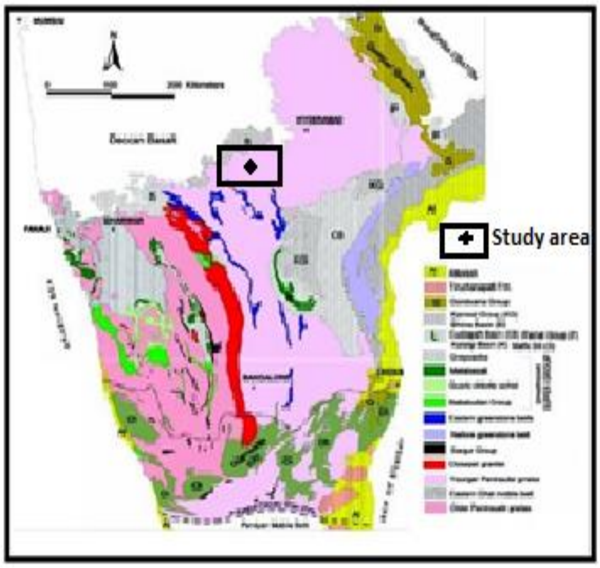

Fig 1. General geological map of the dharwar craton with study area Hindupur Granite region showing the exposed late Archean granite and associated closepet granite, quartz and pegmatite veins.

II. FIELD SETUP

The granitic suite of rocks of Hindpur area form part of the Peninsular Gneissic Complex (PGC) of EDC southern India (Fig.1). Most of the intrusive granites have been dated at 2.5 Ga; the age corresponding to Archaean-Proterozoic

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transition and a period when a major part of continental crust has been stabilised in EDC. The EDC largely consists of these late Archaean granitic intrusions into older TTG gneisses, greenstone belts and calc-alkaline rocks [6]. The HG is a part of the Nrarayanpet Granite Batholith (NGB), perhaps a largest granitic body occupies the northern part of EDC. The NGB contains variety of granite with grain size, color and textural variations. The presence of aplites, quartzofelspathic veins and pegmatites are very common. This batholith is intracratonic, a known equivalent of 2.5Ga Closepet granite. The granite suite of rocks of Hindhpu area is emplaced in an older Basement Complex comprising of amphibolites and deformed migmatites and gneisses. The study area at Hindhpu (Fig.1), in the Hidhupur area Narayanapet District of Telangana, The HG rock is coarse grained, lucocratic, porphyritic to hypidiomorphic texture, exposed at ground level over an area of 6 km^2 and bounded by pink and gry granites. show felsic nature, fine-medium grained rock consists quartz, k-feldsoars , plagioclase and amphibolite enclave (Fig.2C) and tor sheped (Fig.2B) with similar mineralogical characteristics to the surrounding granites. They are emplaced as large bodies that extend for several kilometers and often seen compared to the plutons and/or sheets of granodiorites.

III. ANLYTICAL METHODS

Individual granite were hand-picked by cutting and crushing from the quarries. Three fresh samples were collected during the fieldwork from Hindpur. Petrographical study wascarried out in the Department of Geology, Osmania University using Leica DM EP model petrological microscope. Geochemical analysis of the samples was carried out at the Geochemistry Division, National Geophysical Research Institute (CSIR-NGRI), Hyderabad using XRF (Model: PAN analytical Axios mAX4 wavelength dispersive XRF) to analyse for major oxides and trace elements, wherever as an HR-ICP-MS (Model: Nu AttoM) was used to determine trace and rare-earth element applications. The bulk –rock geochemical data provided in Table 1.

Fig 2 Field photos shows (A) Mafic enclave in granite at the Hindupr,(B) Felsic flow structure with granite east side of Kunsi.(C) . Field photograph showing the Tors at the Kondoddi, (D) Granite exposures at the near temple Hindupur.

IV. PETROGRAPHY

The Hindupur granite is coarse grained, lucocratic, porphyritic, exposed at ground level over an area of 6 km^2 and bounded by pink granites., show felsic nature, fine-medium grained rock consists quartz, orthoclase and plagioclase (Fig. 3B) with similar mineralogical characteristics to the surrounding granites. Magma mixing mingling characteristics are observed at contact margin of the MG body as evidenced by the presence of leucosomes and melanosomes entrainment (Fig. 3C). Petrographically, the MG consists of plagioclase, orthoclase and quartz as essential minerals whereas clinopyroxene,

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hornblende, biotite, apatite, fluorite, opaques, and zircons are accessory minerals. Microcline is anhedral show low relief, formed as interstitial grains with crosshatched twining seems to crystallized at high temperature and inverted to triclinic structure (Fig. 3a).microline is mostly subhydral coarse grained phenocryst surrounded by other anhydral essential and accessory minerals show the porphyritic textures. which is less stable than its counterpart at low temperatures. Quartz occurs as fine to medium grained, mostly anhedral showing ndulatory extinction. Clinopyroxene is medium grained with irregular shapes showing uralitization, whereas the hornblende and opaques shouw intimate association

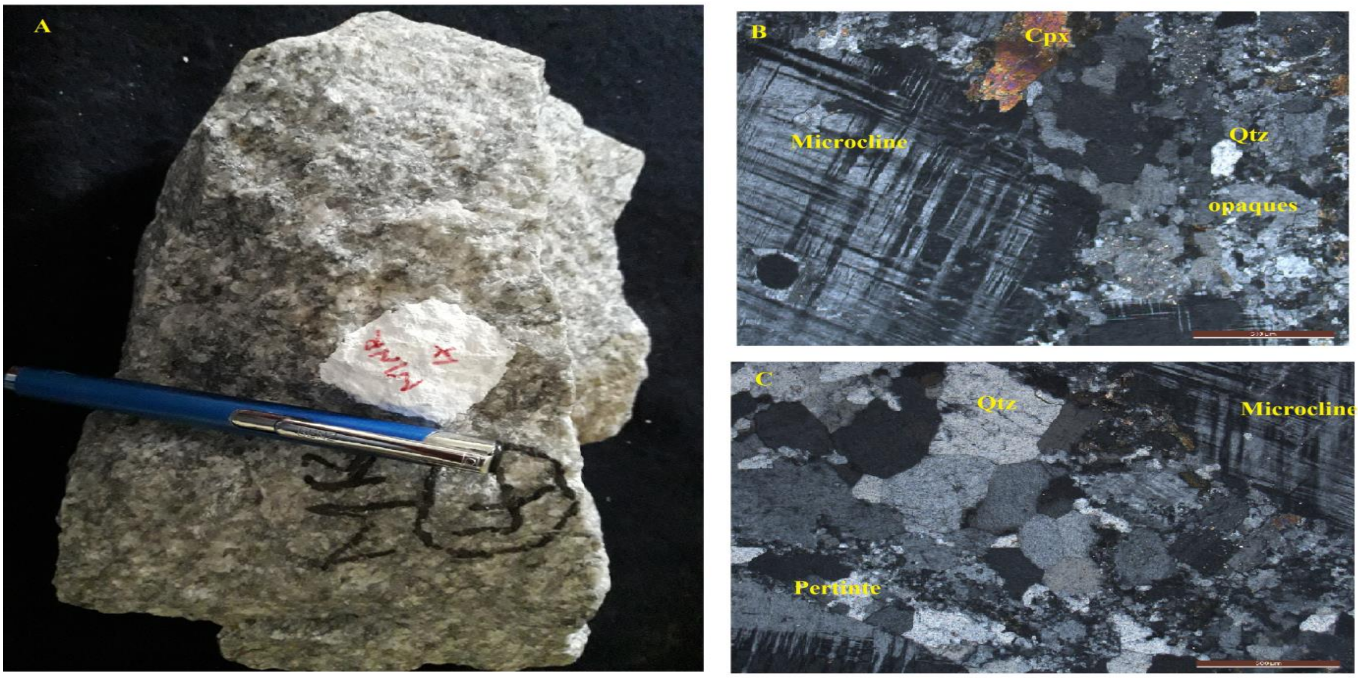

Fig. 3. Photomicrographs of Hindupur granites showing; a) Hand specimen of Hindupur granite; b) Microcline with tartan twining and anhedral shape surrounded by fine acessary associated with opaques; c) Perthite Intergrowth of quartz in altered plagioclase.

V. GEOCHEMISTRY

Geochemical data of Hindpur porphyritic granite presented in Table 1. The data show that SiO_2 content of samples are ranging 60.10 - 66.36% with an average 63.23%; compartive smples 62.85-73.09% with an average 67.48% alkali content (Na_2O + K_2O) 9.55 - 7.0%; CaO contents are 5.66 – 1.81%. These major contents are indicative of high-K calc-alkaline type. Al_2O_3 contents are 17.13-15.29% with aluminium saturation index A/CNK ranging 0.09 – 1.08%. In the feldspar triangle [12] Ab-An-Or diagram and total alkalies Vs silica (TAS) diagram [8] the HG samples plot in the field of granites (Figs. 4a & b). In the SiO2 vs. K_2O diagram of Peccerillo & taylor [14] their compositions range falls in the field of Shoshonite to high-K calc-alkaline series to calc-alkaline series at relatively high K_2O content averaging 6.05% (Fig. 4c). The HG samples in AFM diagram [5] is also exhibiting the calc alkaline nature (Fig. 4d). When plotted in A/CNK-A/NK diagram [17], samples occupy the metaluminous field (Fig. 4e). Further-more, the moderate concentrations of MgO (avg. 2.24wt%), CaO (avge. 4.77wt%) and Fe2O3 (avg. 2.32 wt%) are characteristic for an acidic magma as source. The presence of biotite as one of the main mafic mineral, high concentration of quartz, orthoclase feldspar, albite and smaller amounts of mafic minerals like hornblende and pyroxene indicate an acidic magma as the source. When plotted on K_2O versus Na_2O diagram that the MG showing I-type character as they fall in the I-type granite field (Fig. 4f). Harkar variation diagrams (Fig. 5) for Maganurul granite show that CaO, Na_2O, Al_2O_3, TiO_2, and P_2O_5 decreasing linear trends suggesting crystal fractionation of biotite, hornblende, pyroxene, plagioclase, titano-magnetite and apatite. K_2O, MgO, P_2O_5, FeOt showing increasing trends as SiO_2 increases. Moreover, decreasing is not well defined but is marked by scatter reflected plagioclase fractionation as well as melts contamination. SiO_2 vs Na_2O shows a negative trend. Overall the major oxide data of the samples in Harkar variations diagrams show deferent behavior, where one group fairly showing clear trends, the others are scattered along the poorly defined trend, indicating the crustal contamination of the magma. On the other hand, most of the trace elements are scattered showing no relation with SiO2, except Ba and Sr with positive trends, and Ce, La and Y having slightly negative trends. These features also indicate possible contamination of magma during fractionation.

The HG rocks are predominantly of I-type, as indicated by SiO_2 vs Na_2O discrimination diagrams. On the Rb vs Y+Nb, Y vs Nb, Rb vs Ta+Nb and Ta vs Yb tectonic discrimination diagram of Pearce et al [13], the samples fall in the Volcanic Arc Granite (VAG) field and (WPA) (Fig.6a), indicating magmatic arc setting. The binary variation diagram R1=4Si-11(Na+K)-2(Fe+Ti)R1 vs R2= =6Ca+2Mg+Al (after [2]) indicating that the granite are

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belongs to Late Orogenic collision setting (Fig 6b). Comparison of abundance patterns of the samples show rich in Large Ion Lithophile elements (LILE) and depleted in High Field Strength Elements (HFSE). The MG granite shows Nb, Sr, Ti negative anomalies whereas U, K,Ce, Zr,and DY elements positive anomalies (Fig. 6d). The negative Nb anomaly is suggesting the involvement of crustal material in the magmatic processes. The chondrite normalised Rare Earth elements patterns for the granite show enriched Light Rare Earth elements (LREE) with respect to the Heavy Rare Earth elements (HREE), with well defined, negative Ti, Nb and Sr anomalies, may be due to contamination or mixing of lower crustal melts by upper crustal material (Fig. 6c). The slightly Eu, negative anomalies indicate a less fractionation of plagioclase.

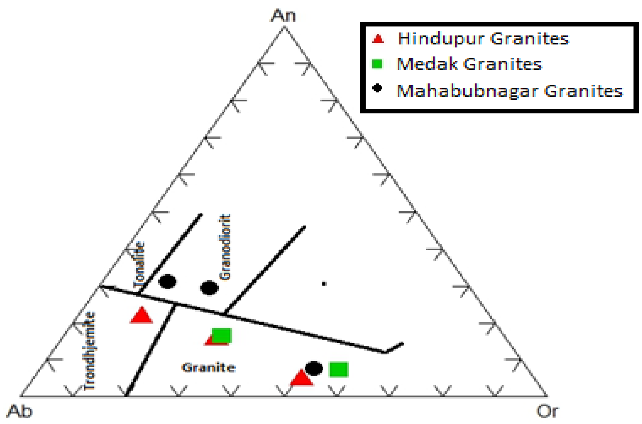


Fig. 4. a) Ab-An-Or diagram for HG showing the Granite nature after O'Connor [12], Symbles: Red triangle Hindupur granites (this study),Green squarevMedak Granites,Black filled circle Mahabubnagar Granites.

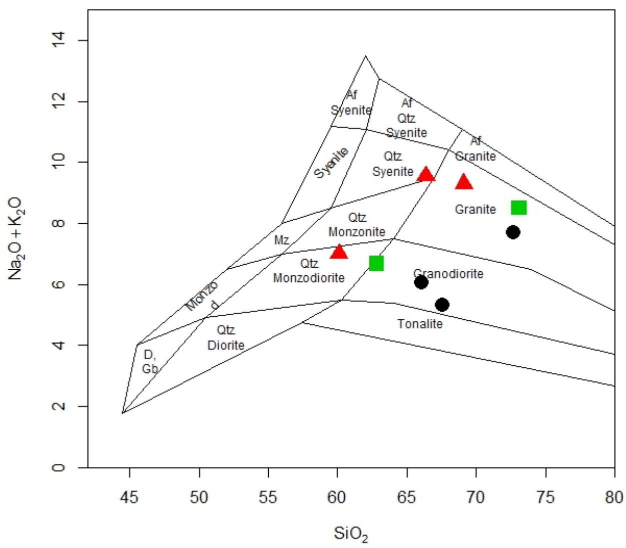
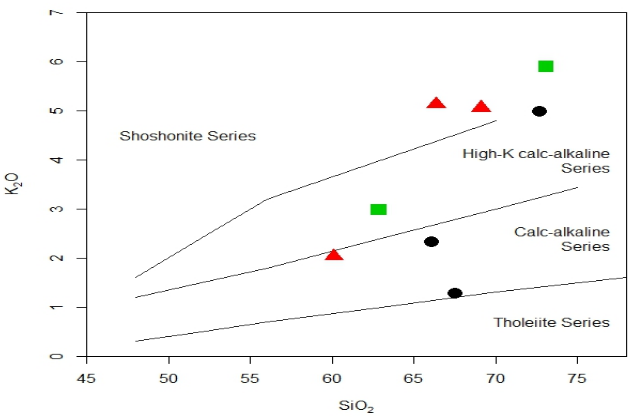


Fig. 4. b) Classification of igneous rocks after Middlemost [8].Symbols same as Fig. 4a.



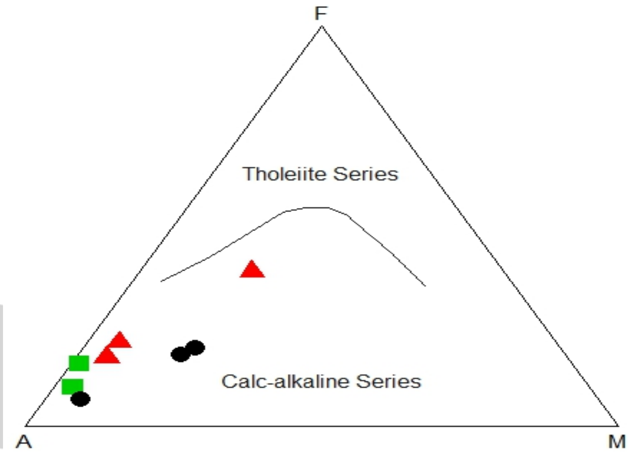
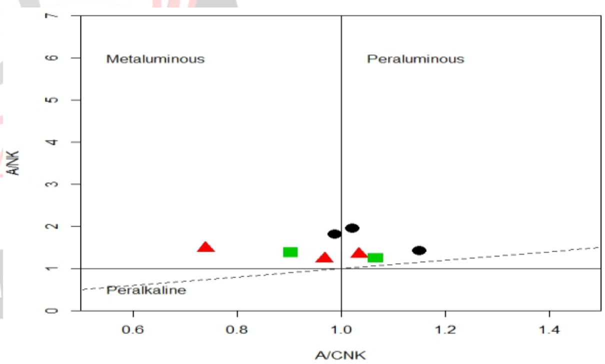


Fig. 4.c) SiO2 versus K2O diagram after Maniar & Piccoli [7] for HG, d) AFM diagram [5] showing the calc alkaline nature, Symbols same as Fig. 4a.



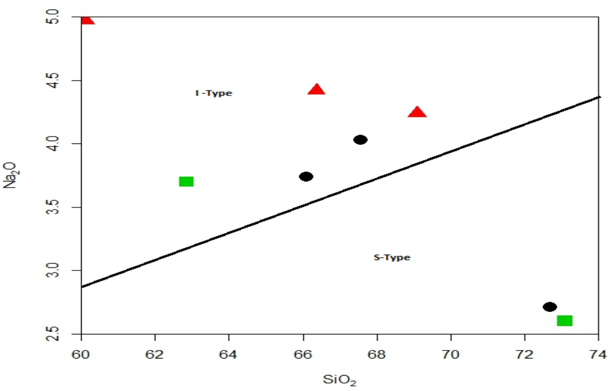


Fig. 4. e) A/NK vs A/CNK diagram [7] for HG depicting the Metaluminous nature, f) K2O versus Na2O diagram showing that HG samples plot in the I-type granite fields, Symbols same as Fig. 4a.

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Table 1 Major and Trace element analyses of the Hindupur granites

S.No	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Sample	HDP-1A	KD-2	KN-1	MG-1N	MG-2S	MNG-1TT	MNG-2TGM	MNG-3MS
SiO_2	60.10	61.09	66.36	62.85	73.09	67.55	66.10	72.70
TiO_2	0.67	0.27	0.17	0.42	0.31	0.40	0.42	0.26
Al_2O_3	15.29	15.28	17.13	12.84	13.32	15.61	15.71	14.04
Fe_2O_3	7.07	2.94	2.35	1.4	1.06	1.86	1.87	0.65
MnO	0.08	0.03	0.02	0.09	0.03	0.05	0.07	0.05
MgO	3.14	0.69	0.65	0.12	0.32	1.65	1.64	0.54
CaO	5.66	1.83	2.05	2.69	1.00	3.99	3.96	1.29
Na_2O	4.97	4.24	4.42	3.70	2.60	4.03	3.74	2.71
K_2O	2.03	5.06	5.13	2.98	5.90	1.28	2.33	4.99
Sc	3.3	3.0	2.1	4.1	7.7	9.0	3.2	11.0
V	33.1	31.3	31.7	7.7	12.2	4.0	6.5	6.4
Cr	18.7	27.0	21.4	38.4	100.4	40.5	35.5	22.3
Co	6.2	4.1	7.6	3.7	13.6	31.7	2.3	14.1
Ni	2.4	2.1	2.5	16.4	27.4	16.1	12.8	10.6
Cu	11.8	5.3	6.5	6.5	5.3	7.1	8.0	7.4
Zn	38.4	25.5	33.5	26.3	30.4	15.6	19.4	21.4
Ga	23.8	19.6	24.0	16.2	15.6	15.0	18.4	19.1
Rb	70.3	189.5	72.5	150.0	68.6	333.5	209.8	98.5
Sr	187.3	293.9	195.9	241.9	396.1	189.3	75.2	433.3
Y	18.5	22.4	23.0	11.3	17.5	25.0	12.4	17.6
Zr	308.1	590.7	249.0	87.7	42.0	169.2	109.2	73.4
Nb	5.5	12.9	7.7	7.8	6.5	15.2	7.0	9.7
Cs	1.4	1.2	4.1	1.3	2.0	2.4	1.6	3.1
Ba	861.4	636.7	432.3	465.2	181.2	469.5	153.8	579.9
Hf	7.7	15.7	7.7	2.2	1.2	6.3	2.8	2.9
Ta	0.4	0.7	0.4	0.6	0.7	0.2	0.5	0.7
Pb	25.8	33.1	25.8	35.3	30.2	25.6	35.5	28.1
Th	15.2	23.6	12.2	15.6	17.0	20.3	21.5	26.1
U	2.6	9.8	2.6	5.9	4.7	26.2	13.4	3.1
La	37.6	75.1	32.7	20.9	13.3	58.2	17.0	46.3
Ce	84.3	150.9	63.7	36.3	27.3	57.5	36.3	100.6
Pr	10.7	16.1	6.4	3.4	3.1	14.6	3.8	11.3
Nd	40.1	51.7	20.2	11.4	12.7	45.8	13.8	43.0
Sm	6.9	7.6	2.6	1.9	2.7	7.2	2.6	8.1
Eu	1.3	1.2	0.5	0.3	0.3	0.5	0.2	0.8
Gd	5.0	5.3	1.6	1.6	2.5	6.0	2.1	5.7
Tb	0.6	0.7	0.2	0.3	0.0	0.6	0.4	0.8
Dy	3.2	3.8	1.8	1.6	2.5	4.2	1.9	4.0
Ho	0.6	0.8	0.2	0.1	0.2	0.4	0.6	0.7
Er	1.6	2.0	0.4	0.6	0.9	1.8	0.6	1.7
Tm	0.2	0.3	0.1	0.1	0.1	0.2	0.1	0.2
Yb	1.4	1.9	0.4	0.9	1.3	2.3	0.7	1.5
Lu	0.2	0.3	0.1	0.1	0.2	0.4	0.1	0.3

Note: S.No.1-3 Present study smples, 4-5Narsapur Medak[20],6-8 Mahabubnagar [21].

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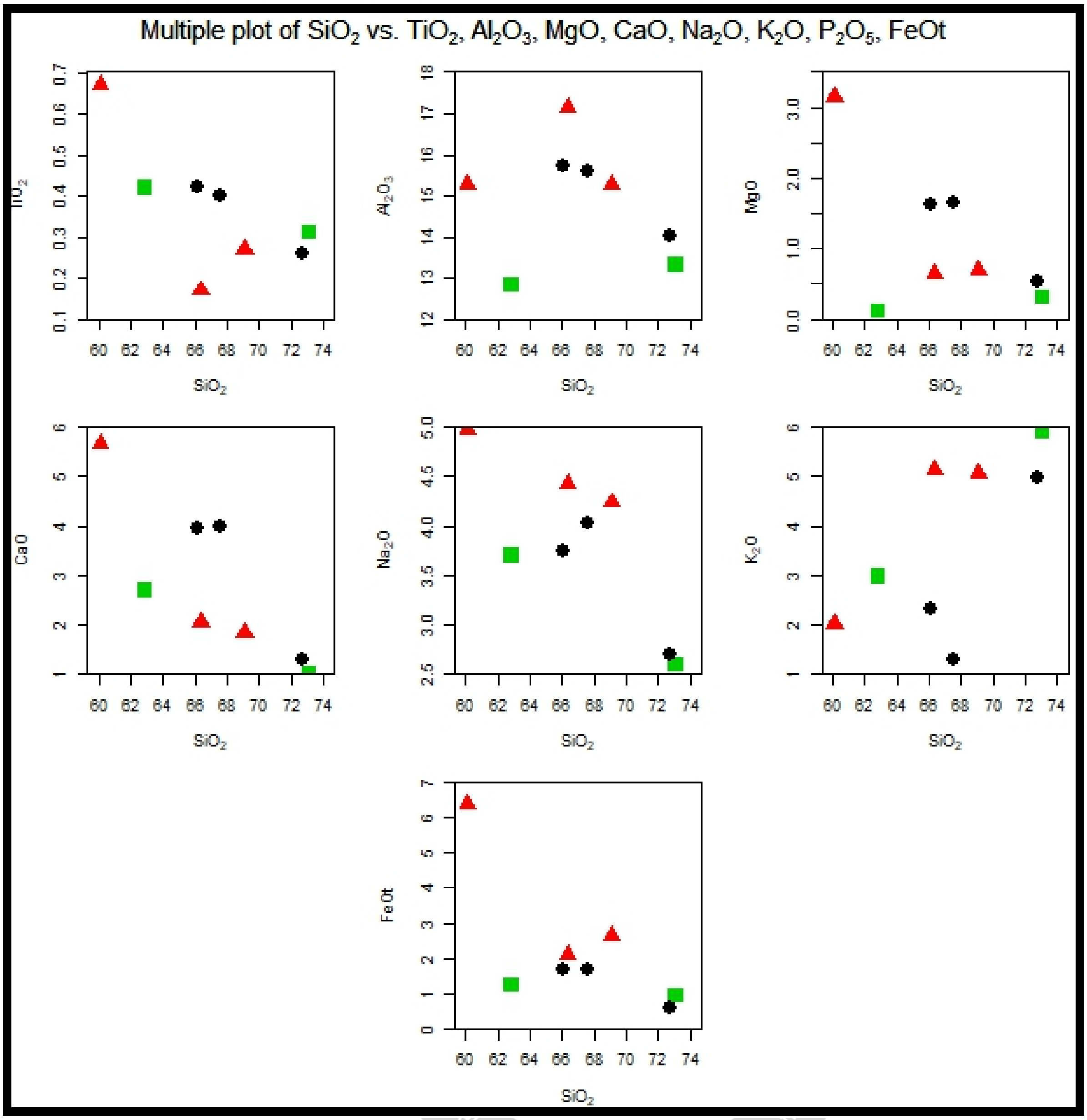

Fig. 5. SiO2 Vs Major oxides for variation diagrams of Hindupur Granites, Symbols same as Fig. 4a.

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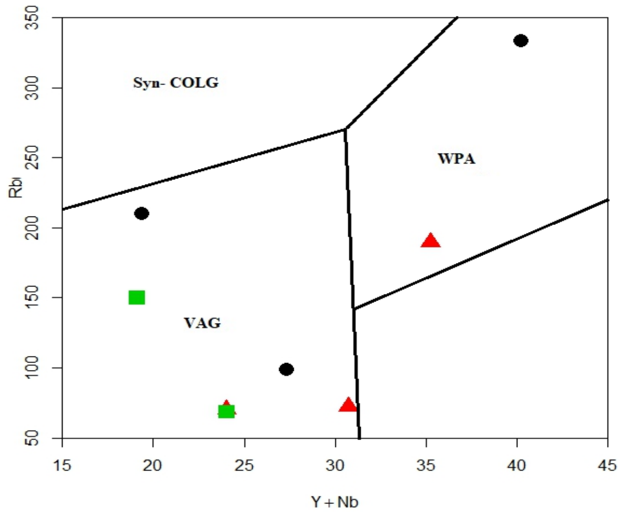

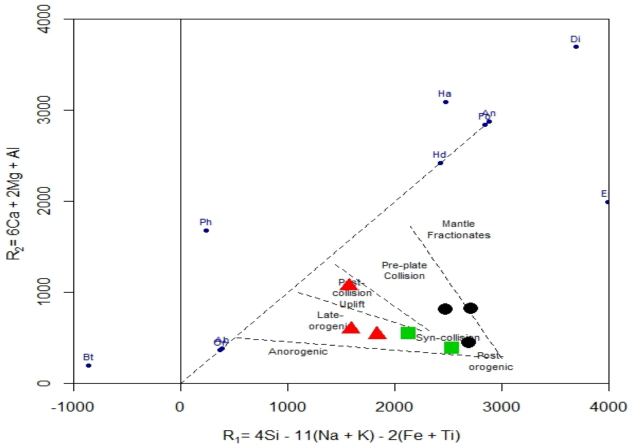

Fig. 6 a) Y+Nb vs. Rb discrimination diagrams [13], showing the tectonic setting of Hindupur granites, b) R1-R2 diagram [2] depicting the position of the HG, Symbols same as Fig. 4a.

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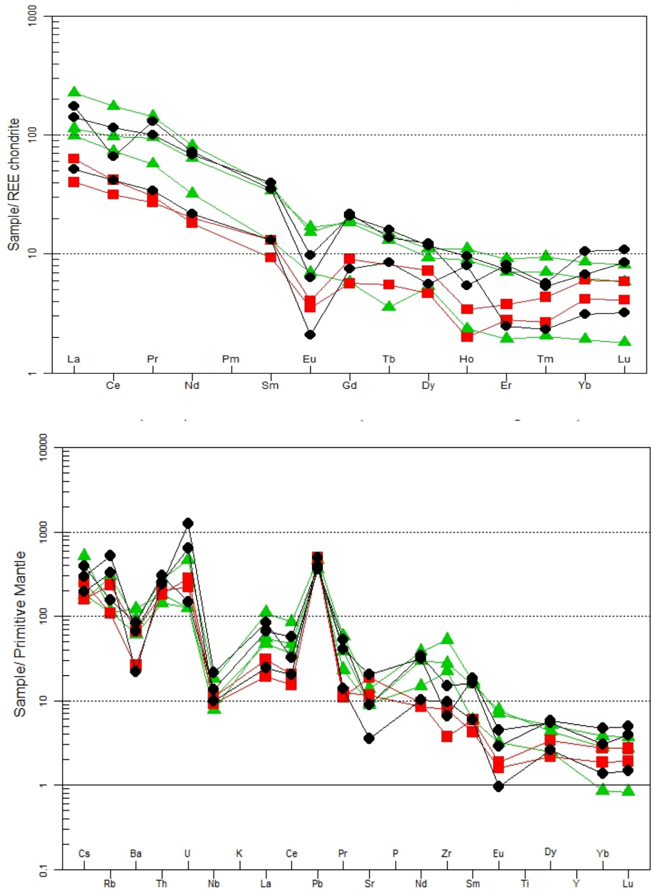

Fig. 7 a) Primitive mantel normalized multi-element diagram [19], d) Chondrite normalized REE diagram for HG [9], Symbols same as Fig. 4a.

VI. CONCLUSIONS

Field evidences suggest that Late Archaean granitoids of Hindupur suggests promoted to undercooling and mingling supported by the presence of amphibolite enclave and Syn-plutonic felsic dykes displaying sharp to diffusive contacts with host granite. Petrographically, the Hindupur granitoids show disequilibrium textures such as quartz ocelli, poikilitic clinopyroxene, and plagioclase, subhedral k-feldspars, developed during magmatic crystallization. It is envisaged that the crystallization temperature of amphibole enclave suggests a higher rate of undercooling in the latter due to the contact producing chilled margin.

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REFERENCES

[1] F. Barker, Trondhjemite: definition, environment and hypothesis of origin, in: F. Barker (Ed.), Trondhjemites, Dacitesand Related Rocks, Elsevier, Amsterdam, , pp. 1–12,(1979).

[2] A Batchelor R, P Bowden, Petrogenetic interpretation of granitoid rocks using multicationic parameters; Chem, Geol48 43–55,(1985).

[3] J. Blundy, K. Cashman, Ascent driven crystallization of dacite magmas at Mount St Helens, 1980-1986, Contributionsto Mineralogy and Petrology 140 631–650,(2001).

[4] C Condie K, Archean magmatism and crustal thickening; Geol, Soc. Am. Bull. 84 2291–2981,(1973).

[5] T.N. Irvine, W.R.A. Baragar, A guide to the chemical classification of the common volcanic rocks, Canadian Journalof Earth Sciences 8 523–548,(1971).

[6] M. Jayananda, M. Santosh, K.R. Aadhiseshan, Formation of Archean (3600–2500 Ma) continental crust in the Dharwar Craton, southern India Earth-Science Reviews 181 12–42, (2018).

[7] P.D. Maniar, P.M. Piccoli, Tectonic discrimination of granitoids, Geological Society of America Bulletin 101, 635-643,(1989).

[8] E.A.K. Middlemost, Naming material in the magma/igneous rock system, Earth-Science Reviews 37 ,215–224, (1994).

[9] N. Nakamura, Determination of REE, Ba, Mg, Na and K in carbonaceous and ordinary chondrites, Geochim. Cosmochim. Acta 38 ,757–775, (1974).

[10] Ch Narshimha, U V B Reddy, V V Sesha Sai, K S V Subramanyam, Petrological and geochemical characterisation ofthe Punugodu Granite Pluton, Nellore Schist Belt; Implications for proterozoic anorogenic granite magmatism in theEastern Dharwar Craton, southern India; J, Indian Geophys. Union 22 ,187–197,(2018).

[11] Ch Narshimmha, K Praveen, K S V Subramanyam, U V B Reddy, Origin of Intergrowth TexturesinKohedaPinkGranite,EastofHyderabad City,India:ImplicationsforAutometamorphic Conditions, International Journal of EarthSciences and Engineering 09 (05) pp.I-II, (2016).

[12] J.T. O'Connor, A classification for quartz-rich igneous rocks based on feldspar ratios, US Geological Survey Professional Paper USGS B525, pp. 79–84(1965)..

[13] J.A. Pearce, N.B.W. Harris, A.G. Tindle, Trace element discrimination diagrams for the tectonic interpretation ofgranitic rocks, Jour. of Petrology. v.25 956–983, (1984).

[14] A. Peccerillo, S.R. Taylor, Geochemistry of Eocene calc-alkaline volcanic rocks from the Kastamonu area, northernTurkey, Contributions to Mineralogy and Petrology 58 63–81, (1976).

[15] K Praveen, M Anjaneyulu, Narshimha Ch, B Reddy U V, Petrology and geochemistry data of the precambrian granitoids from the Hyderabad area, part of Eastern Dharwar Craton, Telangana state, India; Data in Brief 21 1909–1917,(2018).

[16] P Rama Rao, V Divakar Rao, M.V Subha Rao, Geochemisttry of Hyderabad Granite Complex, Andhra Pradesh – Evidence or fractional crystallization pf a crustal anatecticmelts, Jour. Appl. Geochem 3 (2) 133–144, (1999).

[17] S.J. Shand, The Eruptive Rocks, 2nd edn, John Wiley, New York, p. 444, (1943).

[18] Subba Rao, M.V., & Suresh, K. Geochemical characterization of the granites and mafic enclaves of the hyderabad granitic region: implications for crustal growth and evolution Data in Brief 22 1909–1917(2018).

[19] S.S. Sun, W.F. McDonough, Chemical and isotopic systematic of oceanic basalts: implications for mantle compositionand processes, in: A.D. Saunders, M.J. Norry (Eds.), Magmatism in Ocean Basins, GeologicalSociety Special Publication. 42, pp. 313–345(1989).

[20] Ningam N., Phani P. Ramesh Chandra, Srinivas MPetrology and geochemistry of syenogranites from sitarampally area, eastern dharwar craton,Journal of Applied Geochemistry,Vol : 23, Issue : 1,page 1-13.(2021).

[21] Gopal Reddy, T. and Vishwanatha Rao, N. Study of granitic rocks in GadwalMakthal area, Mahabubnagar district, Andra Pradesh. Rec.Geol.Surv.India, vol. 125, pt.5, pp 256-258 (1991).

 DOI : 10.35291/2454-9150.2022.0481