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Field and Petrographic Studies on Granitoids of the Bibinagar-Bhongir Area, Yadadri district, Telangana State, India

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Abstract: *The granitoids of the Bibinagar- Bhongir area from the Yadadri district are confined to a part of the Eastern Dharwar craton. The major rocks types are in the present study area are volumetrically in decreasing order of granite, granodiorite, quartzmonzonite and diorite. They form massive weathered boulders, pointed hillocks and batholithic domes. All these rock types are described as felsic granitoids displayed two main* Phaneritic texture *features: (1) Porphyritic (inequigranular) and (2) non-porphyritic (equigranular), and these textural features have a regional variation from south to north from the study area. Non-porphyritic granitoids (grey granite gneiss, granodiorite and diorite) have fine to medium grained equigranular-hypidiomorphic texture, while the porphyritic varieties (pink granite and quartzmonzonite), and show very coarse to coarse-grained inequigranular porphyritic texture. Field relationships of the granitoids indicate that the porphyries are younger than the non-porphyries due to cross-cutting relations between them. The granitoids are characterized by quartz, K-feldspar (microcline) and plagioclase as* essential minerals *and hornblende and biotite as minor minerals. Augite, Fe-Ti oxides, apatite, zircon and epidote form important accessories. They show massive form with inter locking mineral grains in the field and exhibit typical perthitic, myrmekitic and hypidiomorphic textures under the microscope. Petrographic features of granitoids indicate that they are of "subsolvus granites" by the presences of two feldspars in them. The field relationships and petrographic features of the granitoids suggest that these felsic granites are formed by differentiation and fractional crystallization of felsic magma that is generated by partial melting of lower* Amphibolitic *or diorite crust.*

Keywords: *Granitoid rocks, perthite, myrmekite, subsolvus and felsic magma*

1. Introduction

The term granitoid (sensu stricto) applies to the suite of felsic plutonic rocks that are composed of quartz and feldspar on different proportions. The proportions of these minerals define the rock types. Plagioclase feldspar predominates in tonalite and alkali feldspar is abundant in alkali granite and both feldspars are present and granodiorite. Trondhjemite is a variety of tonalite that is usually quartz rich and contains sodic, not calcic plagioclase. The proportion of mafic minerals varies from 20-40% of hornblende and biotite in granodiorite and hornblende only in tonalite. Pyroxene, micas (biotite and muscovite) and hornblende are found less found less proportion in granite, adamellite, quartzmonzonite and other felsic rocks.

Most of the granitoids of significant volume occur in areas where the continental crust has been thickend by Orogeny, their continental arc subduction or continental collision. Many of them may be postdated the thickening event by few tens of millions of years. Because the crust is solid in its normal state, some thermal disturbance is required to form granitoids. The general consensus of many petrologists is that the granitoids are derived by either partial melting of crustal or differentiation mantle material [1].

The granitoids of the study area fall within the Eastern Dharwar Craton and occupy northern part of Yadadri district of Telangana state. The study area is bounded by latitudes 17˚30´00″ to 17˚80´00´´N and longitudes 78˚45´00″ to 79˚00´00´´E. It covers an area of about 260 sq. km within the Survey of India toposheet nos 56 K/14 & 56 K/15.

The area mainly comprises of granite, granodiorite, quartzmonzonite and diorite of Precambrian age and form a part of unclassified crystalline terrain of Peninsular Gneissic Complex (PGC) of the Eastern Dharwar Craton [2,3,4 and 5]. The granitic rocks (broadly granitoids) with granite-adamellite-granodioritic (GAG) composition and occur as granite gneisses, migmatites within plain country, and pink and grey granite porphyries stand as isolated hillocks, mounds and batholithic domes. They are intruded by younger dolerite dykes (Proterozoic age, granite-adamellite, [6] gabbros and pegmatite veins on a larger scale to quartz and epidote veins on smaller scale. Mafic xenoliths with amphibolitic or dioritic composition are rarely encountered in granite gneisses.

The topmost granitic crust has covered with good fracture system and these brittle fractures are commonly filled with younger intrusives like dolerite dykes, pegmatites and quartz veins (Figure 1). The

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direction and frequency of fractures in granitoids are shown in a rose diagram (Figure 2). This diagram indicates that most of the fractures are trending NNW-SSE and NE-SW. Some minor fractures are in other directions especially in N-S&E-W. As per field observations, NNW-SSE trending fractures occur at an interval of about 10 cm to 30 cm. On the other hand, NE-SW fractures are maintained at a distance greater than 80 cm. Majority of these fractures are steeply dipping with dip angle greater than 80^0. Further, horizontal fractures are also present at a distance from 30 cm to 60 cm, which can be observed in quarry sites and excavations. All these surface manifestations of the study area are quite comparable with those of other areas in the EDC [5&7].

2. Field and petrographic characteristics of the granitoids

Granitoids occurring in the area are classified into distinct rock types, based on their field characteristics, texture, mineral content and colour. Previous studies on this terrain, the rocks are classified mainly on colour as primary criterion and it has become a convention to categorise these rocks into pink and grey granites. It is very hard to separate granites on colour in a regional scale in fact they occur together as composite mass in the field. [8] Has pointed out that the Hyderabad granites do not have age difference in between grey and pink varieties and they may be formed from different melts during granitization process. This coloured based classification of granitoids was abandoned and widely following mineralogical classification of IUGS by recent workers [7].

2.1 Grey granite

Grey granites frequently cut by irregular quartz veins, epidote veins, pegmatite, dolerite and basic enclaves. Deformation and alteration of both feldspars are frequently noticed. The grey granites contain dark inclusions of small to large dimensions with different shapes of mafic enclaves (Figure 3a) are frequently noticed. Such features are not observed in pink granite and it is one of the characteristic differences between grey and pink granites. The Grey Granite is characterized by dark grey in colour, massive and coarse grained. It shows equigranular (Figure 3b) to inequigranular texture and contains chiefly quartz, plagioclase feldspar and alkali feldspar in that order of abundance. Hornblende & biotite form subordinate mafic minerals. Magnetite, fluorite, apatite and epidote occur as accessories. The plagioclase feldspar is dominant over K-feldspar, and hornblende is greater than biotite in grey granite. The muscovite is practically unnoticed in these rocks.

2.2 Pink granite

The outcrops of pink granite are in the form of massive boulders or sheeted masses (Figure 3c). These rocks occasionally exhibit cross-cutting relationships with grey granites (Figure 3d). The Pink Granite is characterized by pink in colour, massive form, and medium to very coarse-grained. They show a variety of textural features like equigranular, inequigranular and porphyritic (Figures 4a, 4b, and 4c). The primary minerals of granites include quartz, plagioclase, K-feldspars, hornblende and biotite as essential minerals. Augite, apatite, zircon, epidote and opaque constitute minor phases. The secondary alteration products are represented by kaolinisation; sericitisation and chloritisation (see Figure 4c). In the QAP modal diagram [9&10] of granites fall within monzogranite field (Figure 5). Quartz is commonly occurs as colorless subhedral to anhedral grains, and it shows first order grey and yellow polarisation colours with wavy extinction (see Figure 4b). Quartz occurs in association with alkali feldspar (microcline) and plagioclase and its grain size varies from 1.5 mm to 3 mm. The K-feldspars are coarse grained (average size of 2 mm) and show string perthitic and myrmekitic textures (see Figures 4c&4d). The modal compositions (Table 1) of granite is quartz (20-37%), K-feldspar (25-40%), plagioclase (26-37%), biotite (3-5%) and hornblende (2-15%). These rocks are plotted in the monzogranite field of QAP diagram (Figure 5).

2.3 Granodiorite

The granodiorites are well exposed at Kondamadugu, Nagireddipalli (Erukala gutta) and Indranagar in Bibinagar Mandal. These rocks are second to granites in aerial extent (see Figure 1). Like granites, they also show both equigranular to porphyritic textures. Plagioclase forms phenocrysts that are surrounded by mafic clots (Figures 3e&3f). Granodiorites are medium to coarse grained and grayish white in colour. They show inequigranular and hypidiomorphic granular textures. They predominantly contain plagioclase, quartz and hornblende. K-feldspar is sub-ordinate or less to plagioclase. Biotite is subordinate to hornblende. The accessory phases include epidote, apatite, zircon and magnetite. Quartz grains exhibit microfold along with plagioclase, hornblende and biotite (see Figure 4e). Its grain size varies from 0.5 mm to 1.5 mm. Granodiorites mainly consist of quartz (21-24%), K-feldspar (18-20%) and plagioclase (40-42%). Biotite (2-4%) and hornblende (11-18%) form subordirite minerals (Table 1). They are plotted at the margin of granodiorite field of QAP diagram (Figure 5).

2.4 Quartzmonzonite

The outcrops of quartzmonzonite are in the form of detached patches, small hillocks massive domes and mounds. At places the dark coloured inclusions of small to large dimensions with different shapes are noticed. Magmatic flow fabrics with fragments were observed within the quartzmonzonite at SE of Indranagar. The quartzmonzonites are characterized by grayish white in colour and medium to coarse

grained. They are massive with equigranular to inequigranular textures noticed at Madhapuram and porphyritic texture with phenocrysts of K-feldspar at Hanumapur (Figures 3g&3h). They contain chiefly K-feldspar and plagioclase feldspar in equal proportion. Quartz, hornblende & biotite are subordinate minerals. Magnetite, fluorite, apatite, zircon and epidote are of accessories minerals. They generally have equal proportion of microcline and plagioclase feldspar (Figure 4f). These rocks exhibit both perthitic and myrmekitic textures (Figure 4g). The modal compositions (Table 1) are as follows: quartz (14-15%), K-feldspar (30-37%), plagioclase (28-37%), biotite (5-6%) and hornblende (6-10%) in quartz monzonites (Figure 5).

2.5 Diorite

Diorites are megascopically massive, mesocratic and fine to medium grained granular rocks (Figures 3i). They are occasionally cut by felsic granite veins (Figure 3j). These rocks are less abundant than granites, granodiorites in the field. Diorites are mainly composed of sodium-rich plagioclase with lesser amounts of hornblende and biotite and they usually contains little quartz. The minor accessory minerals in these rocks are chlorite, sphene, epidote, iron ores and apatite. Based on mineralogical characteristics and their textural habit of minerals in diorite, these rocks show both hypidiomorphic and foliated textures (Figure 4h). The modal composition (Table 1) of diorites is quartz (2-3%), K-feldspar (4-6%), plagioclase (58-60%), biotite (5-8%) and hornblende (18-22%). These rocks are plotted at the P- corner of QAP diagram (Figure 5).

3. Conclusions

The Bibinagar-Bhongir granitoids occupy a part of the Eastern Dharwar craton. They are earlier mapped as a single undifferentiated granitic massif. Detailed field and laboratory investigations reveal that they have been formed as composite body comprising of several magmatic intrusive phases. Four genetically related types of granitoids were deciphered and delineated from the Bibinagar-Bhongir area as 1) granite, 2) granodiorite, 3) quartz monzonite and 4) diorite/gabbro.

Porphyritic (inequigranular) and non-porphyritic (equigranular) granitoids occur with a regional variation from south to north of the study area. Non-porphyritic granitoids have fine to medium grained (grey granite gneiss granodiorite and diorite) texture with dark/grey colour in the southern part of the area and they are different from the porphyritic varieties (pink granite and quartzmonzonite), which have very coarse to coarse-grained texture with light/pink colour in the northern part of the area. Field relationships of the granitoids of the area indicate that the porphyries are younger than the non-porphyries. Both exhibit hypidiomorphic granular texture. Enclaves of basic rock material are occasionally observed. Three sets of joints are more pronounced along NE-SW, NNE-SSW and NNW-SSE; and sometimes E-W and N-S effects of shearing indicated by shear folds and close spaced joints. Field observations reveal that granitoids are predominantly represented by two distinctive suites of granitoids, viz. pink and grey granites, with gradational or diffusive contact relationship.

The granitoids are characterized by primary major mineral assemblage of quartz, K-feldspar, plagioclase, hornblende, biotite and minor mineral assemblage of augite, apatite, zircon and epidote. They show massive form with inter-locking mineral grains in the field and exhibit typical perthitic, myrmekitic and hypidiomorphic textures under the microscope. The QAP plots of granitoids exhibit distinct fields from diorite through quartz monzonite, granodiorite and granite (grey to pink) in the area and they majorly form a granite-Adamellite-Granodiorite-Diorite (GAGD) suite of rocks. Petrographic features of granitoids indicate that they are of “subsolvus granites” by the presences of two feldspars in them.

The field relationships and petrographic features of the granitoids suggest that the felsic granites are formed by amphibolitic or dioritic magmatic differentiation and fractional crystallization of felsic magma, which is generated by partial melting of lower and trace element geochemistry of granitoids (reserved for next publications) from Bibinagar-Bhongir area can solve somemore problems related to chemical classification and tectonic setting of their rocks crust.

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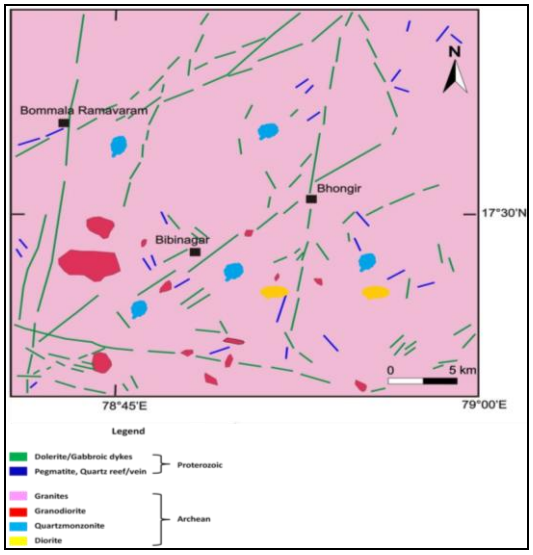

Figure 1. *Geological Map of the granitoids from Bibinagar-Bhongir area*

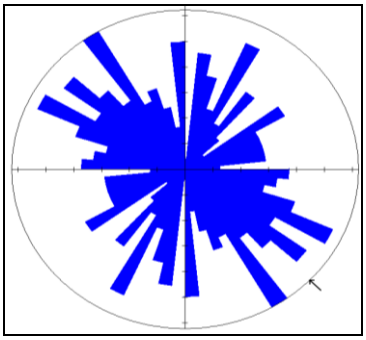

Figure 2. *Rose diagram of fracture system in the granitoids from Bibinagar-Bhongir area*

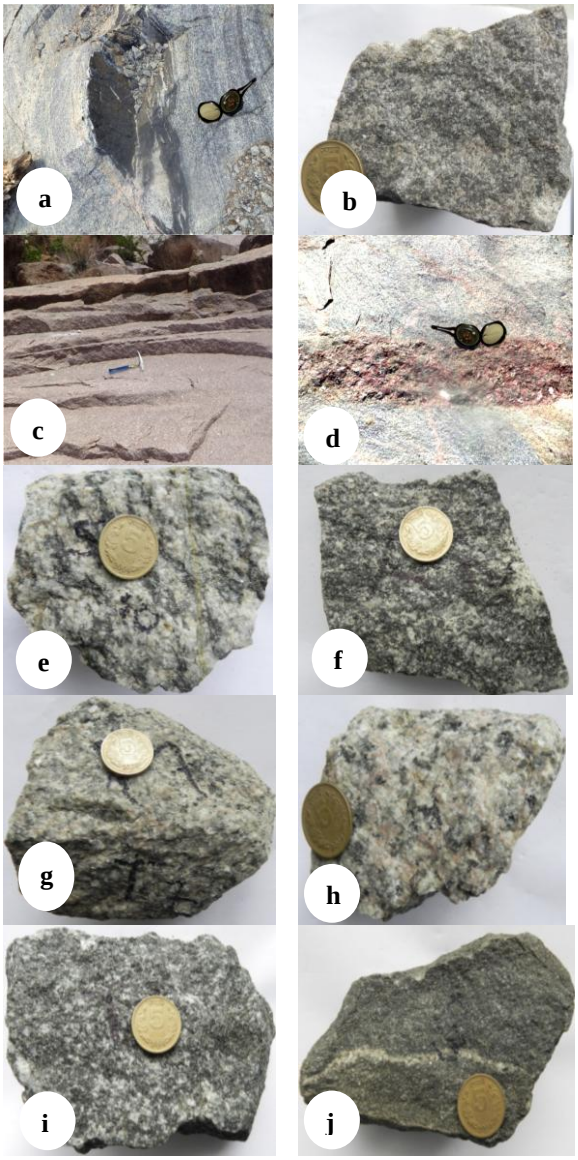

Figure 3. *Description of field photographs of granitoids*
(a). *Large mafic enclaves in grey granitic gneisses at Pedda Kondur.* ***(b).*** *Equigranular grey granite at Anjapur.* ***(c).*** *Pink granite occurring as massive boulders and sheeted outcrops at Masireddi-palli.* ***(d).*** *K-feldspar granite band cutting grey granite at Hanumapur.* ***(e).*** *Granodiorite showing porphyritic texture with phenocrysts of plagioclase (white).* ***(f).*** *Granodiorite showing equigranular texture at Nagireddipalli.* ***(g).*** *Quartz-monzonite showing equigranular, coarse-grained texture at Padamatisomaram.* ***(h).*** *Quartz-monzonite showing porphyritic texture with phenocrysts of K-feldspar at Hanumapur.* ***(i) .*** *Coarse grained diorite at Yapaganitanda. Note: big grayish white plagioclase make-up > 60% by volume.* ***(j).*** *Medium grained diorite at Nagireddipalli. Note: granite vein cutting host diorite.*

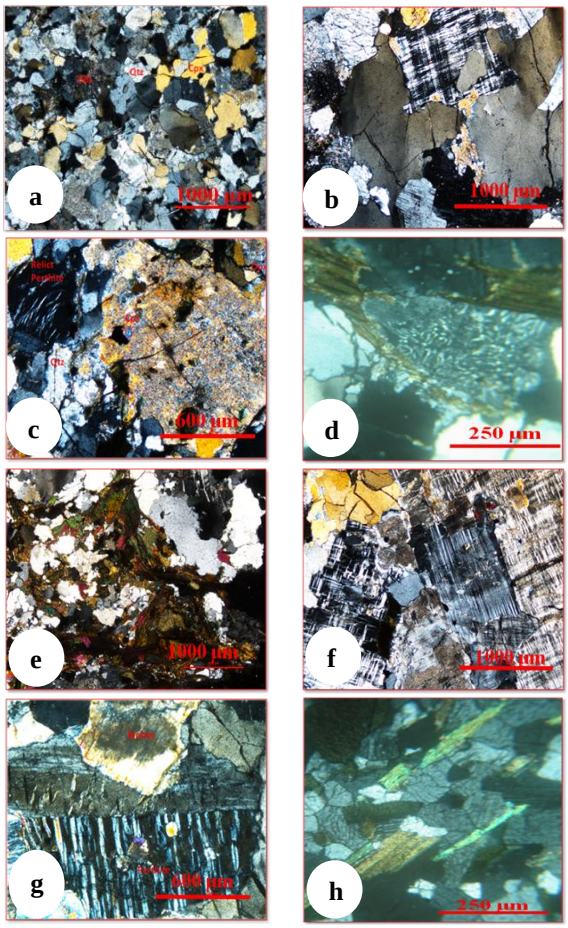

Figure 4. *Photomicrographs of granitoids (a). Photo-micrograph of granite showing equigranular texture at Anjapur. (b). Photo-micrograph of granite showing inequigranular texture with deformed quartz at Medpalli. (c). Photomicrograph of altered granite showing string perthite at Anjapur. (d). Photomicrograph of granite showing myrmekite texture at Pagidipalli. (e). Granodiorite at Kondamadugu showing altered amphibole with fine grained quartz. (f). Coarse grained microcline showing crosshatched twinning zoned plagioclase in quartzmonzonite at Bibinagar. (g). Photomicrograph of flame perthite with simple twinning in quartzmonzonite at Padamatisomaram. (h). Diorite showing foliated texture with parallel grains of tabular amphibole at Nagireddypalli*

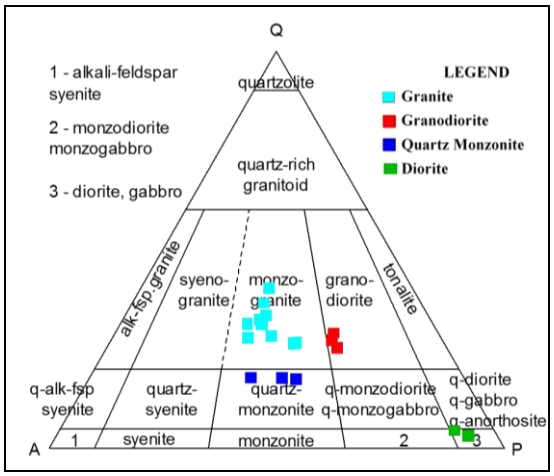

Figure 5. *The QAP modal mineralogy classification scheme for the rocks of the Bibinagar-Bhongir granitoids (after Streckeisen, 1974, Le Maitre et al., 1989)*

Table 1: *Modal analysis of granitoids of the Bibinagar- Bhongir area*

Rock name	Granite										Granodiorite			Quartzmonzonite			Diorite	
Sample No	MI-1	AJ-1	PP-1	IN-2	NA-1	MP-1	HP-1	TG-1	AP-1	PP-2	IN-1	NG-2	KM-1	PS-2	PS-1	MA-1	YT-1	NG-1
Quartz	37	34	30	30	29	28	26	26	24	20	24	20	21	14	15	14	3	2
K-Feldspar	29	32	32	35	38	34	34	40	29	25	19	18	20	37	34	30	6	4
Plagioclase	26	27	28	28	26	28	32	28	37	31	40	36	42	28	36	37	60	58
Biotite	3	4	5	4	4	4	4	3	4	5	2	4	2	6	5	5	5	8
Hornblende	0	0	2	0	0	2	0	2	2	15	11	18	12	10	6	9	22	18
Others	5	3	3	3	3	4	4	1	4	4	4	4	3	5	4	5	4	10
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100