Field Relationships and Petrographic Characterization of Darsi Granite from Nellore Schist Belt, Eastern Dharwar Craton, Andra Pradesh, South India

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***Abstract*—In this work, we describe the in-situ field and petrographic observations of the Darsi granite pluton, which is located in the Nellore schist belt of the Eastern Dharwar Craton in South India. The Darsi granite pluton, which is located to the north of Darsi town, is a leucocratic granite pluton that is trending in a north-northeast-southwest direction and covering an area of 6 square kilometers. Field investigations have shown that the Darsi granite is deformed along the edges and lineation. In certain locations, mafic clots have been detected, which is evidence of the intrusive character of the granite. Although observed from a petrographic perspective, the rock is mostly K-feldspar, with quartz, amphibole, plagioclase, and biotite serving as subordinate components, indicating hypersolvus nature. Apatite, zircon, titanite, fluorite, and opaques are the phases that are considered to be accessory. The CIPW normative data of the Darsi granite exhibits alkali feldspar to syeno granite composition, which is comparable with petrographical features. The alkali content makes it abundantly evident that the Darsi granite is of the A-type.**

***Index Terms*—Alkali feldspar granite, Darsi granite, Nellore schist belt, EDC.**

I. INTRODUCTION

A-type magmatic provinces are prevalent in the Earth's crust and have originated since the Archean era due to geodynamic processes linked to extensional tectonic settings. A variety of rock types characterizes A-type magmatism, each exhibiting distinct petrographic and geochemical fingerprints (Whalen et al., 1987; Eby, 1990; Poitrasson et al., 1995; Litvinovsky et al., 2002; Vilalva & Vlach, 2014). Proterozoic A-type granite magmatism has been documented at the eastern boundary of the Cuddapah basin (Reddy, 1989; 1991). Moeen (1998) conducted mineralogical investigations and pressure-temperature estimations of the lithological units within the Nellore Schist Belt (NSB). Adjacent to the eastern periphery of the Cuddapah basin (Nagaraja Rao et al., 1987; Tripathy & Saha, 2015), a regional curvilinear shear zone, designated as the Terrain Boundary Shear Zone (TBSZ) was delineated along the western edge of the Nellore schist belt (Chetty & Murthy, 1994; Chetty, 1999). The TBSZ is regarded as a crustal-scale shear zone and a significant tectonic structure located west of the Eastern Ghat Granulite Belt (EGMB) in South India (Chetty, 2017). A substantial area of Proterozoic granite magmatism was identified in the NSB, next to the eastern boundary of the Proterozoic Nallamalai Fold Belt (Sesha Sai, 2013a; Sesha Sai, 2016). Calc-silicate bands have been documented in proximity to Kanigiri granite and Podili granite (Prasada Rao & Ahluwalia, 1974). Srinivasan and Roop Kumar (2007) observed that pyroclastic volcanism manifested as agglomeration. Banerjee et al. (1983) discovered rare metal mineralization in the granite around the Kanigiri region, while Dharma Rao and Reddy (2007) conducted trace element and geochronological research on the Kanigiri granite. The Mesoproterozoic Kanigiri granite (Gupta et al., 1984; Sain et al., 2017) is situated west of the Punugodu pluton. The Punugodu granite pluton was first identified by Reddy and Sesha Sai in 2003. Saha et al. (2015) investigated the tectonostratigraphic development of the Nellore Schist Belt. We provide in-situ field observations and petrographic data of the Darsi granite pluton within the Nellore schist belt, elucidating the spatial link between the pluton and adjacent NSB lithological units.

II. GEOLOGICAL CHARACTERISTICS OF DARSI GRANITE

The current research region is located at the interface of the Nellore Schist Belt (NSB) and the Cuddapah Basin/Nallamalai Fold Belt (Fig. 1a). Proterozoic granite plutons are located along the eastern edge of the Cuddapah basin at Vinukonda, as well as south of Vinukonda, Darsi, Podili, and Kanigiri in the northern region of the NSB (Fig. 1a). Granites located at Vinukonda, south of Vinukonda, and Darsi is situated at the tri-junction formed by the northern tip of the Nallamalai Schist Belt (NSB), a segment of the Peninsular Gneissic Complex (PGC), and the eastern boundary of the Nallamalai Fold Belt (NFB). In contrast, the Kanigiri biotite granite and Podili alkali granite plutons are positioned along the interface of chlorite schist, agglomerate tuffs, and intercalated quartzite, which belong to the Udaigiri Group of the upper NSB to the west, and sheared granite to the east (Prasad Rao & Ahluwalia, 1974; Srinivasan & Roop Kumar, 1995). Enclaves of schistose litho units from the earlier NSB are prominently seen in the Kanigiri-Podili and Darsi granite plutons, with deformed basement biotite granite gneiss (PGC). The Darsi granite pluton, located north of Darsi town, is an NNE-SSW trending leucocratic granite pluton that includes small hills and covers an area of 6 square kilometers. Two sets of deformational fabrics are seen in the Darsi pluton: (i) NNE-SSW trending shear, notably around the margins, and (ii) N-S foliation with modest easterly dips ranging from 25° to 30°. To the west of the Darsi pluton (Fig. 1b), NE-SW trending granite masses are situated within the quartzite-schist of the NSB, in the Bodanampadu-Chalivendra regions, close to the eastern boundary of the Cuddapah basin.

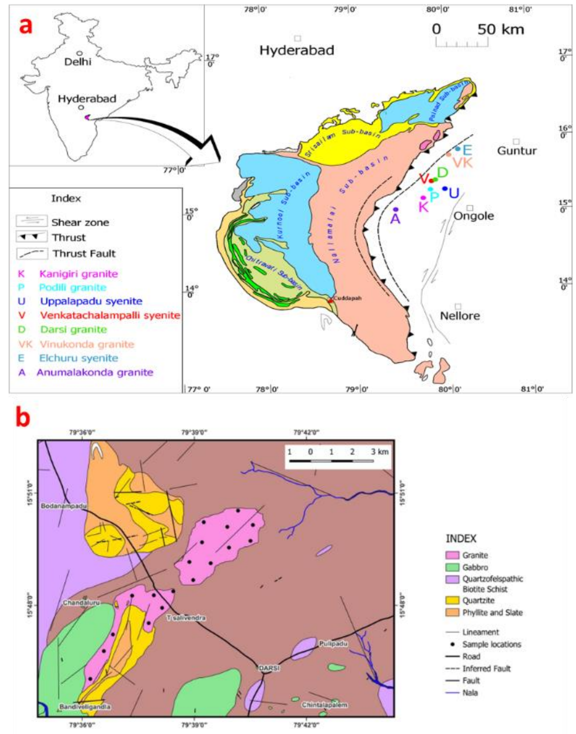

Fig.1 a) Geological map of the Cuddapah Basin (modified after Geological survey of India, 1988). b) Geological map of the Darsi granite pluton.

III. RESULTS AND DISCUSSIONS

The Darsi granite is mesocratic, phaneritic, massive, equigranular, and coarse-grained. To the west of the Darsi pluton, NE-SW trending granite body are situated within the quartzite-schist of the NSB, in the Bodanampadu-Chalivendra regions, in close proximity to the eastern boundary of the Cuddapah basin. The granitic rocks are medium- to coarse grained massive rock with meso-leucocratic color (*Fig. 2. a,b)*. The easily identifiable minerals to the naked eyes are alkali feldspar, quartz, plagioclase and biotite. At places large phenocryst of K-feldspar is observed within the granitoids. The granites have mafic phenocrysts with preferred lineation (Fig. 2 c). At places small mafic patches in the study area (Fig.2c).

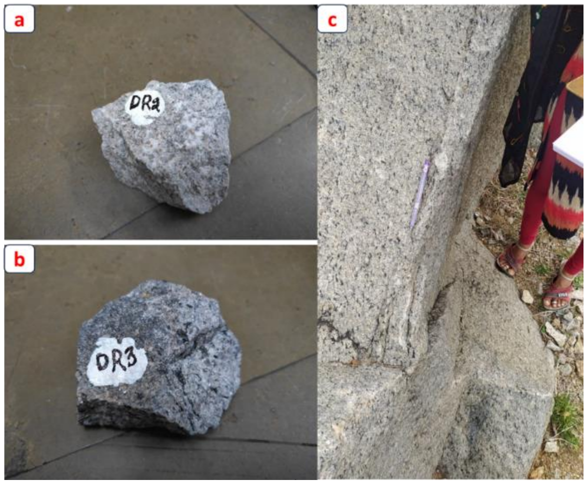

Fig. 2. Representative field photographs of the study area illustrating the general characteristics of the granite. a) The Granites show light pink in color with feldspar phenocrysts. b) The Granites show mesocratic in color with mafic phenocrysts. c) fresh granite sample showing the mineral proportions.

Quartz is an essential mineral, fine to coarse grained, anhedral, shows wavy extinction. At places brittle, recrystallized and intensely squeezed into perthitic phenocrysts is a characteristic feature of mylanization. Lobate grain boundaries, and ductile deformation feature observed in the quartz is, therefore, created in a relatively high temperature condition. Quartz experienced ductile deformation at lower temperatures than feldspar (Tullis and Yund 1977). Quartz has been far more deformed into elongated subgrains, which were appears to have flowed around the perthite grains (*Fig. 3a, e)*. Quartz is recrystallized and exhibits progressive extinction indicating deformation. At some places, quartz comb layers and veins occurred within perthite.

Perthite is essential constituent, occurs as euhedral, coarse grained with low relief (*Fig. 3b,c,d)*. Generally, the grains are characterized by twinning while some are untwined. Based on (shape and content) the nature of occurrence of the albite content, three types of the perthites could be recognized. These are termed as string perthite, vein perthite and patch perthites. Each of these three defined with distinct characteristics. The grains of the perthite is mostly equigranular, however the shape of the crystals quite controlled by the type of the perthite, i.e. most of the patch perthites are not well-developed euhedral crystals (*Fig. 3 c)*. Large grains of perthite surrounded by fine grained matrix of quartz, biotite, amphibole, and opaque minerals (*Fig. 3d)*. Perthite also hosts for the inclusions of biotite and opaque. At some places large microcline ‘microperthite’ fragmented and distorted. Plagioclase fragments formed as inclusions hence they can be seen as xenocrysts. However, plagioclase grains are rarely present along the perthite boundary as accessory phase (*Fig. 3b)*. Perthite phenocrysts are micro fractured at some places. Sometimes, intergrowth textures such myrmekite and graphite observed along with perthite (*Fig. 3.e)*. Fractures are filled with quartz and formed as comb structures that may be result of intense deformation under brittle-ductile demise. Overall, the specimens exhibit a considerable variation of brittle and ductile deformation features. Micro fractures are evidence for brittle deformations. Kinked twins of perthite show the effect of ductile processes. Since features were caused by ductile deformation were only slightly obscured by brittle fracture at places. Where brittle deformation is more intense. Grain size is reduced further by multiple fractures, creating micro breccia/fragments. Rarely, the feldspar crystals have moderately altered to saussuritization (*Fig. 3f)*.

Biotite occurs as an important accessory mineral, having very fine to moderately coarse in grain size. Shape of the grain is euhedral to subhedral, brown in color, pleochroic and mostly formed as clusters (*Fig. 3d,e)*. It is highly characterized and noticed as randomly oriented flex. Interstitial biotite flakes between amphibole indicates late-stage crystallization. At some places biotite flakes in alkali amphibole mineral is observed. Opaque grains rimmed by biotite flakes is one of the most common features, hence the flakes are radial to the center. The fine-grained biotite minerals are accorded as small inclusions in the perthite and mostly as clusters associated with other mafic mineral like amphibole, zircon, sphene and opaques. At some places biotite flakes are elongated and also formed as veins.

Amphibole is one of the main mafic silicate minerals, is anhedral, bluish green in color, pleochroic and mostly large grained consists inclusions of biotite, zircon and opaque minerals (*Fig. 3d)*. Hornblende, arfvedsonite and riebeckite are the amphibole minerals identified along the other mafic minerals and opaque. Hornblende is brownish, pleochroic with high relief and highly associated with mafic minerals. Zircons are mostly euhedral but size varies from fine to moderately medium up to 1mm size show high relief. Zircons are associated with mafic minerals and also occurred as inclusions in perthite phenocrysts, and at some places they also found in fluorite mineral. Zoning is clearly visible in zircons that hosted by perthite phenocrysts.

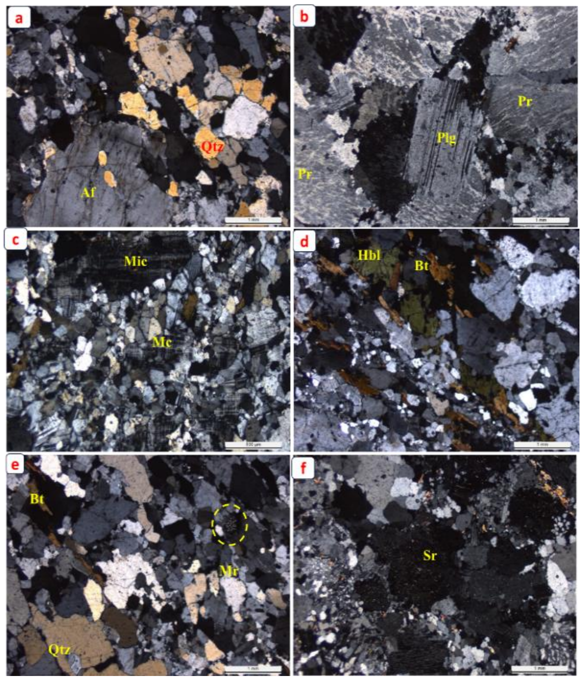

Fig. 3. Representative microphotographs illustrating the petrographic characteristics of the Darsi granite. a) Moderately coarse-grained alkali feldspar enclosed by the quartz. b) Moderately coarse-grained plagioclase enclosed by the perthite. c) Moderate microcline surrounded by the ground mass that comprises quartz, biotite, and opaques. e) Intergrowth texture of myrmekite observed in the study area. f) the feldspar grains alter to saussuritization.

Sphene formed as an accessory mineral, less in abundance; they are mostly euhedral in shape. Occasionally, grains are anhedral and elongated, mostly associated with mafic accessory minerals. A zoning like texture (possibly reaction rim) formed around the sphene, probably due to late-stage crystal-melt interaction. Plagioclase is neither essential nor accessory mineral, but rarely seen as inclusions possibly as xenocrysts. Within the phenocrysts of the perthite these xenocrysts are mantled with the quartz grains is a rare phenomenon which indicate that plagioclase is parent rock mineral fragment. These are also showing lamellar twinning. Along the grain boundary of perthite, small plagioclase laths (secondary) are noticed. Plagioclase is essentially noticed as exsolved phase in host K-feldspar resulting in widespread development of micro perthite intergrowth in the hyper solvus Darsi granite. Fluorite grains are mostly coarse grained, anhedral, moderately low relief associated with biotite and opaques. These are fragmented at some places and hosting for quartz inclusions. Apatite is fine grained, mostly euhedral, showing high relief occurred as an accessory phase.

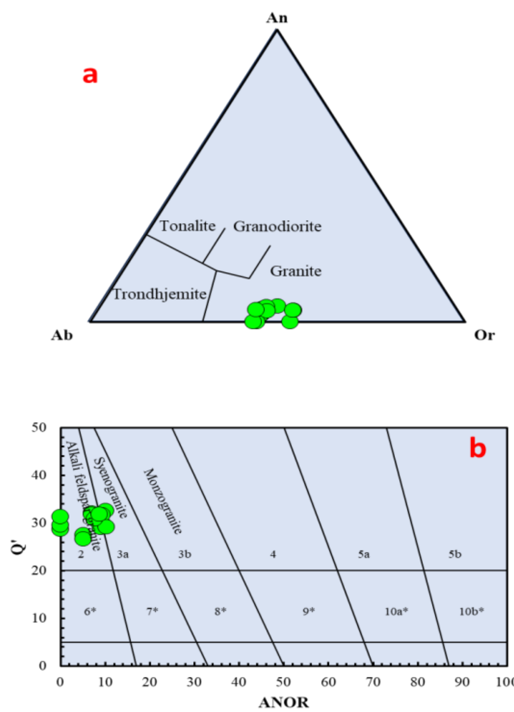

Fig. 4. a) CIPW normative Ab-Or-A ternary classification diagrams exhibits granite composition (After O'Connor 1965) for Darsi granite. b) CIPW normative Q vs ANOR binary plot shoes alkali feldspar to syeno-granite (Streckeisen 1979) for Darsi granite.

As discussed in the petrography observations, the Darsi granite consists consist large amount of feldspar that is microcline micro perthite. The CIPW normative data of the Darsi granite, when plotted in feldspar triangle diagram (O'Connor 1965) show the granite in nature (Fig. 4a) and Q vs ANOR plot exhibits alkali feldspar to syeno-granite composition (Streckeisen 1979) (Fig. 4b). It is obvious that the studied pluton is a granite as for as the nomenclature and classification mentioned above. However, on similarity with petrographical characteristics, the alkali content clearly indicates that it is A-type.

IV. CONCLUSIONS

The paper presents the field and petrographic of the Darsi granite pluton of Nellore schist belt, Eastern Dharwar Craton, South India. The deformed nature along the margins and lineation with mafic clots indicate the intrusive nature. The alkali feldspar enriched Darsi granite with sub ordinate quartz, amphibole, plagioclase, biotite represents to hypersolvus in nature. The CIPW normative data of the Darsi granite represents alkali feldspar to syeno-granite composition which similarity with petrographical characteristics, the alkali content clearly indicates that it is A-type.

V. ACKNOWLEDGMENT

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