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Contrast in deformational structures between the north western and northern margin of the Eastern Ghats Mobile Belt

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ABSTRACT

The NE-SW trending Mesoproterozoic Eastern Ghats Mobile Belt (EGMB) is juxtaposed against the Cratons of Peninsular India along the Terrane Boundary Shear Zone (TBSZ), that has been studied with respect to shear kinematics, on its NW and N margin. Field mapping and microfabric study indicate the NW margin possesses a north-westerly vergence thrust kinematics while the N margin shows dextral slip kinematics. Both the shear zones are synkinematic and belong to a transfer system.

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NW-Thrust

N-Strike slip

1. INTRODUCTION

Peninsular India consists of a number of Cratons namely Bundelkhand, Bhandara (Bastar), Dharwar, and Singhbhum Craton (Fig. 1a). The Marwar Craton that lies to the west of Aravalli mountain is metacratonised during Neo-Proterozoic Delhi Orogeny, as a result, the rocks show Mesoproterozoic age. All these cratons underwent rifting and closed during Proterozoic Eon, creating mobile belts. The Proterozoic mobile belts are namely, Aravalli-Delhi, Satpura (Central India Tectonic Zone/CITZ), Singhbhum, Chhotnagpur, Eastern Ghats, and Southern Granulite Terrane. The contact between the Cratons and the mobile belts is marked by shear zones that vary in shear kinematics at different parts. At places they are marked by thrusts and at others, they are strike-slip shear zones. In many instances, they are reactivated as normal faults. The contact between the Eastern Ghats Mobile Belt and the Dharwar-Bastar-Singhbhum craton is defined by the Terrane Boundary Shear Zone (Fig. 1b; TBSZ, Biswal et al., 2007) which varies in the sense of shear from a thrust in the SW and NW-part, to strike-slip in the north. The TBSZ is a Pan-African structure (517 Ma, Biswal et al., 2007). In this paper, we are characterizing the shear kinematics of the TBSZ around Jatgarh (NW margin) and Kamakhyanagar (N margin) and interpreting that the shear zones in the north and NW belong to a large-scale transfer system.

2. PREVIOUS STUDIES

The western and northwestern TBSZ has been studied by several workers (Chetty and Murthy, 1994; Biswal et al., 1998; Biswal and Sahoo, 1998; Neogi and Das, 1998; Biswal and Jena, 1999; Gupta et al., 2000; Biswal, 2000; Biswal et al., 2000, 2002, 2004; Biswal and Sinha, 2003; Bhadra et al., 2004; Upadhyay et al., 2006; Biswal et al., 2007; Pisarevsky et al., 2013; Nasipuri et al., 2018). Summarily, the western TBSZ is a SE inclined thrust which is developed prominently on the 2.5 Ga K-feldspar rich granites of the Bastar Craton. The shear zone is marked by mylonitic foliation, down-dip stretching lineation, and several types of porphyroclasts that unequivocally indicate an NW vergence of the thrust, implying that the EGMB has been thrust over the Bastar Craton. The EGMB rocks including khondalite, charnockite, and granites were thrusted in form of multiple nappes over the Bastar Craton. The granulite facies rocks of the EGMB have been sheared and retrograded to amphibolites locally along the thrust. Towards SW, the

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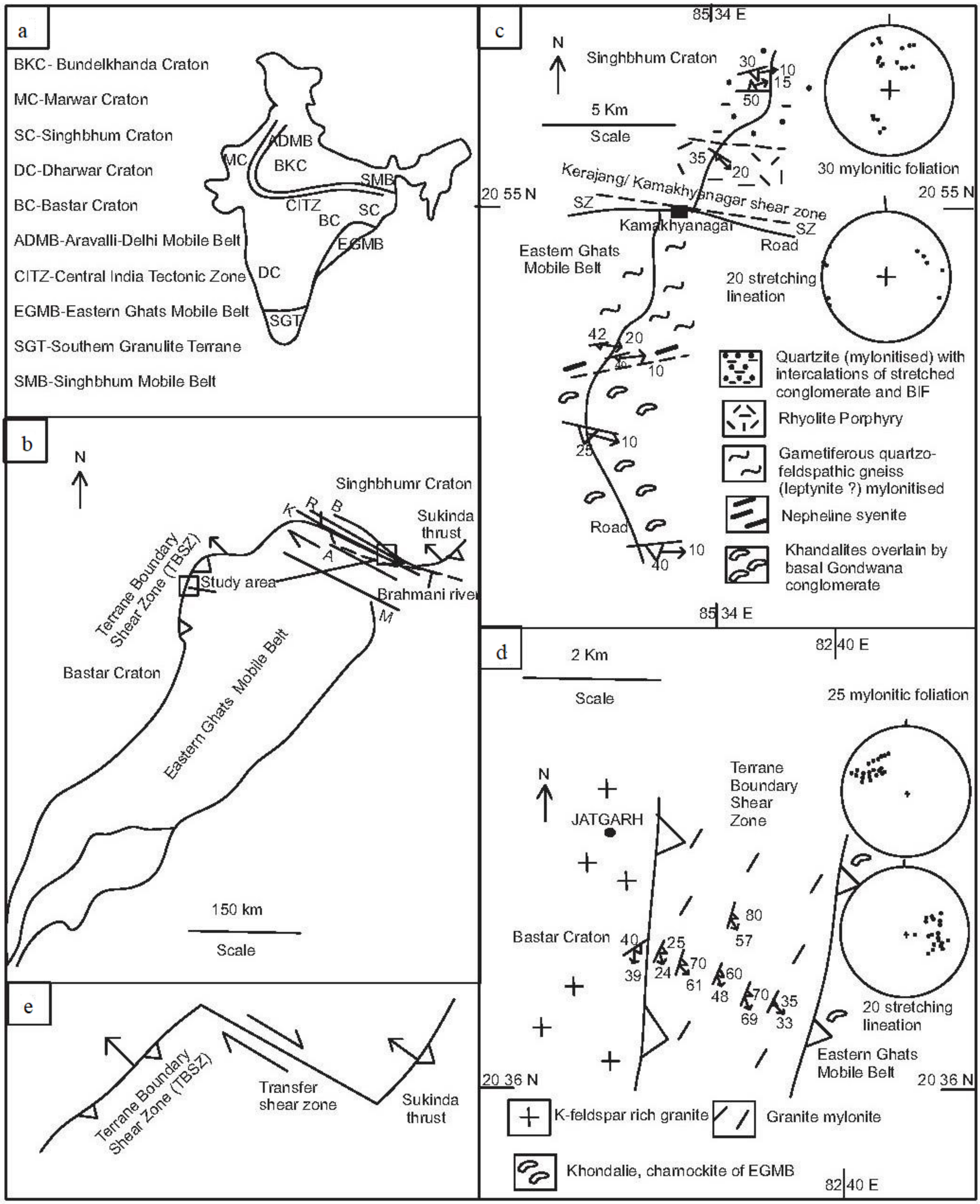

Fig. 1. (**a**) Index map of India showing cratons and mobile belt, (**b**) Map of EGMB showing the TBSZ and other shear zones, M-Mahanadi shear zone, K-Kerajang/Kamakhyanagar shear zone, R-Riamal shear zone, B-Barakot shear zone, A- Angul shear zone (**c**) Preliminary traverse geological map of Kamakhyanagar area, with stereoplot (**d**) Preliminary traverse geological map of Jatgarh area, with stereoplot, (**e**) Schematic map of the transfer system between thrust and strike slip shear zone.

TBSZ is developed on the TTG and greenstone assemblages of the Bastar-Dharwar Craton. The effect of thrusting of granulite facies rocks on low-grade assemblages has been termed as hot slab thrusted over cold rocks. Several nepheline syenite bodies are emplaced along the TBSZ. These are characterized by a magmatic fabric that is coplanar with a solid state shear fabric. As the age of the syenite rocks was determined to be 517 Ma, the thrusting is interpreted to be ∼517 Ma. However, it has also yielded an age of 1480 Ma, which may represent a xenocrystic age. The adjoining granite (2.5 Ga) of the Bastar Craton has been intruded by Lakhna dyke swarms that vary in composition from rhyolitetrachyte to dolerite which has been dated to be 1450 Ma (Ratre et al., 2010). The northern margin is also studied by a number of authors (Mahalik, 1994; Nash et al., 1996; Aftalion et al., 2000; Crowe et al., 2003; Chetty, 2001; Mahapatro et al., 2009, 2011; Misra and Gupta, 2014; Ranjan et al., 2018; Sheikh et al., 2020; Bose et al., 2020; Bose and Gupta, 2018; Ghosh et al., 2021; Bose et al., 2021). Like that of the western margin, the nepheline syenite on the northern margin has produced bimodal ages of e.g., ∼1400 Ma and 520 Ma. Several WNW-ESE shear zones are demarcated, some of them lie in the Singhbhum Craton and some in the EGMB. The shear zones are namely Mahanadi, Kerajang, Riamal, and Barakot shear zones (Fig. 1b). They show dextral shear kinematics and have modified the strike of the intervening blocks into the WNW-ESE trend. The Rengali province has been mapped including the litho units lying between Kerajang and Barakot shear zones (Nash et al., 1996; Crowe et al., 2003). The Riamal shear zone lies within the Rengali province. The rocks lying between Kerajang and Riamal shear zones consist of high-grade rocks and were previously included within EGMB (Ramakrishnan et al., 1998), which, however, didn't yield any Mesoproterozoic age; the Palalahara gneiss is dated to be ∼2.8 Ga (Bose et al., 2021).

3. METHODOLOGY

We have mapped the TBSZ around Jatgarh and Kamakyanagar. Oriented samples are collected from the mylonites from Riamal-Kerajang shear zones and nepheline syenite intruded along the shear zone. Petrographic and microstructural analysis were conducted on the vorticity normal plane.

4. RESULTS

4.1. Geological map

The area north of Kamakhyanagar (Fig. 1c) shows the presence of basal conglomerate, BIF, quartzite, rhyolite intrusive. To the south of Kamakhyanagar, the garnetiferous quartzofeldspathic gneiss (leptynite), khondalite and Gondwana rocks are exposed. The garnetiferous quartzofeldspathic gneiss in the south is intruded by nepheline syenite. This marks the lithological contrast between the northern and southern parts of Kamakhyanagar.

The northern part constitutes part of Singhbhum Craton and the southern part probably belongs to EGMB. However, garnetiferous quartzofeldspathic gneiss which was earlier classified as Kamakhyanagar gneiss (Palkam gneiss, Mahalik, 1994) may be equivalent to 2.8 Ga Palalahara gneiss. The Kerajang shear zone passes through Kamakhyanagar (more appropriately the shear zone can be called Kamakhyanagar shear zone). It is a WNW-ESE shear zone and the width of the shear zone may be around 3 km that covers the entire stretch of the mapped area. Streoplot of structural data shows southerly dipping foliation and nearly subhorizontal E-W trending stretching lineations (Fig. 1c inset). The foliations include mylonitic foliation in quartzite, garnetiferous quartzofeldspathic gneiss, and magmatic foliation in nepheline syenite. Lineations are stretching lineations. The TBSZ in the NW part of the EGMB shows the NE-SW strike (Fig. 1d). It was previously named the Lakhna Shear zone (Biswal et al., 2000). To the east of the shear zone, there lie the khondalite and charnockite rocks of the EGMB, and to the west lies the K-feldspar rich granite of the Bastar Craton. The shear zone is developed on the granite. The width of the shear zone is nearly two kilometres. The stereoplot of the mylonitic foliation shows a dip towards SE and the stretching lineations are almost down dip (Fig. 1d inset).

4.2. Field structures

The quartzite occurring to the north of Kamakhyanagar shows near vertical mylonitic foliation and moderately plunging stretching lineation (Fig. 2a). The nepheline syenite intruded into garnetiferous quartzofeldspathic gneiss to the south of Kamakhyanagar is marked by horizontal lineation (Fig. 2b). The

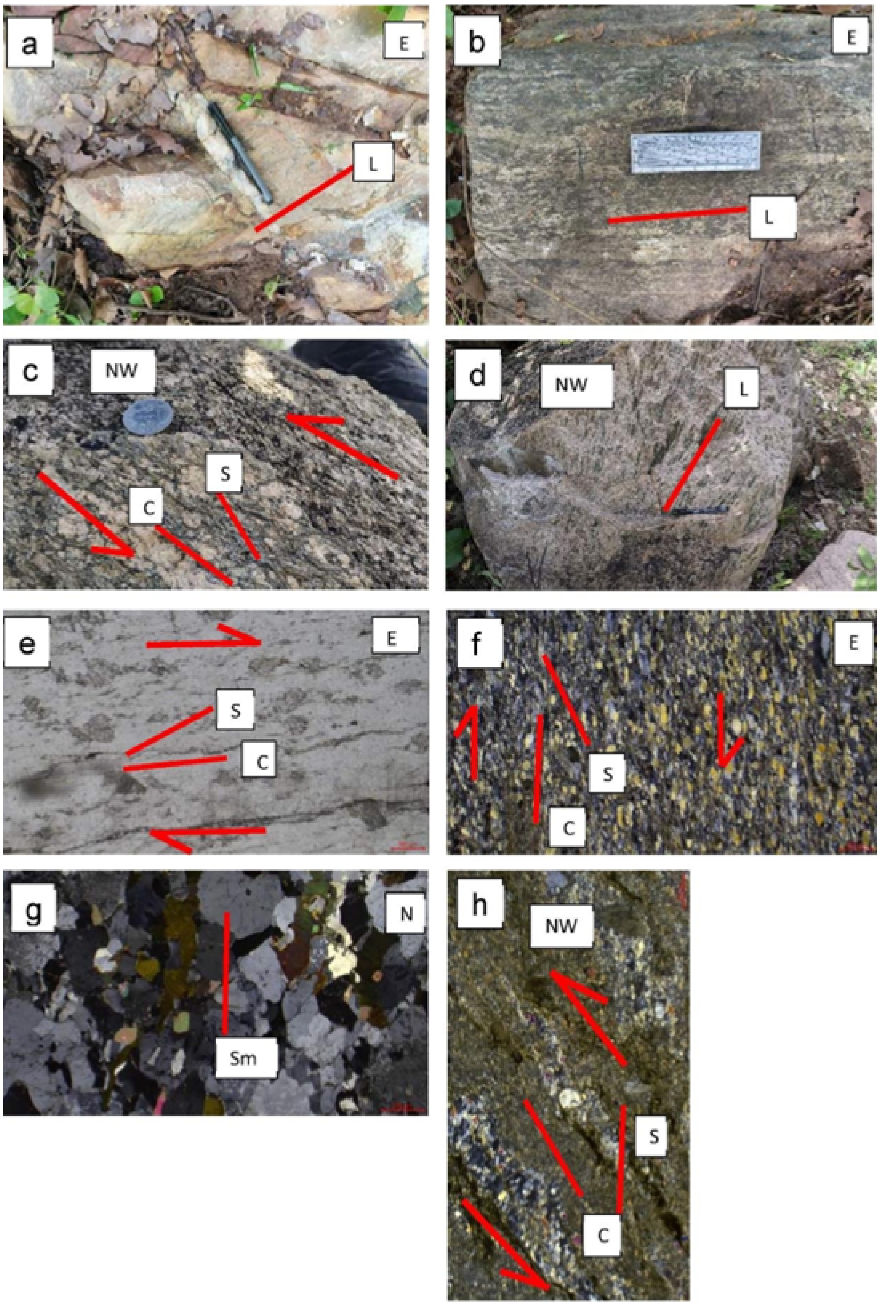

Fig. 2. (**a**) Stretching lineation(L) in quartzite, vertical view, (**b**) Magmatic lineation (L) in nepheline syenite, parallel to stretching lineation in host garnetiferous quartzofeldspathic gneiss, vertical view, (**c**) S-C fabric showing NW vergence of thrusting, vertical view, (**d**) Stretching lineation in granite mylonite, vertical view, (**e**) S-C fabric in mylonites, seen on horizontal section, (**f**) S-C fabric photomicrograph showing dextral shearing, horizontal section, (**g**) Magmatic foliation (Sm) in nepheline syenite due to parallel alignment of hornblende and feldspar grains, horizontal section (**h**) S-C fabric in mylonite showing NW vergence of thrusting, vertical section.

mylonites in the western margin TBSZ around Jatgarh is marked by S-C fabric suggesting NW thrusting (Fig. 2c) and down the dip stretching lineation (Fig. 2d).

4.3. Microstructures

The quartzite occurring to the north of Kamakhyanagar shows asymmetric sigmoidal porphyroclasts (Fig. 2e) and S-C fabric (Fig. 2f) on the horizontal section. From the position of the tails in the sigmoidal porphyroclasts and the acute angle position in the S-C fabric, a dextral shearing has been interpreted. This suggests that the EGMB has moved westward with respect to Singhbhum Craton. The garnetiferous quartzofeldspathic gneiss occurring to the south of Kamakhyanagar shows S-C fabric and nepheline syenite shows magmatic fabric parallel to the C-fabric in the host garnetiferous quartzofeldspathic gneiss. The magmatic feldspar laths, nepheline, and hornblende in the nepheline syenite are aligned to define the magmatic fabric in the rock (Fig. 2g). The mylonites in the NW terrane margin near Jatgarh carry several shear kinematics namely S-C fabric, sigmoidal porphyroclasts, and mica fishes which indicate an NW vergence thrust kinematics for the terrane boundary thrust (Fig. 2h). The EGMB granulite has been overthrusted the Bastar Craton.

5. DISCUSSION

(i) The TBSZ shows a contrast in shear kinematics between the NW and N margin of the EGMB. Our study reveals that thrust kinematics was predominant in the NW margin while dextral shear kinematics was present in the northern margin. The strike-slip shear zone is therefore interpreted as a transfer fault of the NW frontal thrust system (Fig. 1e). The age of thrusting along the NW margin and strike-slip shearing in the northern margin is ∼517 Ma.

(ii) The northern margin of the EGMB has several shear zones namely the Mahanadi shear zone, Kamakhyanagar shear zone (Kerajang), and Riamal shear zone. All of them show similar trends and dextral kinematics. Because of these multiple shear zones, the litho units in the north have been aligned into the WNW-ESE direction. Further, the enechelon arrangement between these shear zones has produced a transtensional setting (Misra and Gupta, 2014) that led to the rifting of the EGMB crust and the formation of Gondwana basins.

(iii) The Rengali Province lying between the Kerajang/Kamakhyanagar shear zone and Barakot shear zone consists of high-grade as well as low-grade rocks that belong to the Archean age. The structure of the Rengali province is oriented in the WNW-ESE direction which is different from the N-S structural trend of the Singhbhum Craton. The WNW-ESE trend is the result of the rotation of pre-existing structures by dextral shearing. Hence we are interpreting that the Rengali province may represent a composite of high-grade,

greenstone, and TTG terrane of the Singhbhum Craton. This is comparable with Salem- Namakal block (Charnockite block) lying south of the Dharwar Craton.

6. CONCLUSION

We conclude that the EGMB is juxtaposed against the Cratons along the TBSZ, which vary in their shear kinematics. In the west, it acts as an NW vergent thrust and in the north, it is a dextral strike-slip shear zone. The strike-slip shear zone may be a transfer structure of the NW frontal thrust.

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CONFLICT OF INTEREST

The authors have no conflict of interest regarding this work.

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