Journal of Structural Geology 59 (2014) 1–17

Contents lists available at ScienceDirect

Journal of Structural Geology

journal homepage: www.elsevier.com/locate/jsg

Superposed deformation and inherited structures in an ancient dilational step-over zone: Post-mortem of the Rengali Province, India

Surajit Misra, Saibal Gupta*

Dept. of Geology & Geophysics, Indian Institute of Technology, Kharagpur 721 302, India

ARTICLE INFO

Article history:
Received 17 September 2012
Received in revised form
2 July 2013
Accepted 14 November 2013
Available online 3 December 2013

Keywords:
Rengali Province
Dilational step-over zone
Strike slip
Superposed deformation
Transpression
Transtension

ABSTRACT

In the eastern Indian shield, a dextral strike-slip system juxtaposed the Archaean Singhbhum Province against the Proterozoic Eastern Ghats Belt at ~490–470 Ma. Two WNW–ESE trending strands of the strike-slip system enclose a multiply deformed (D_1 to D_3) intervening domain called the Rengali Province, with D_3 representing dextral shearing. In a granulite lens within the province, an early fabric (S_{gr}) was deformed by an amphibolite facies D_1–D_2 deformation continuum in the late Archaean time, forming cylindrical folds. In the surrounding quartzofeldspathic gneisses, quartzites and mica schists of the province, superimposition of syn-D_3 shortening on D_1-D_2 folds generated complex non-cylindrical geometries; the granulites escaped D_3 strain. Microstructures in the province-bounding shear zones confirm that D_3 deformation was associated with mylonitization, dynamic recrystallization and greenschist facies metamorphism. In the quartzites, syn-D_3 folds can be correlated with rotation of D_1–D_2 structures through the shortening zone of bounding dextral shears. Since the province-bounding shears form a step-over zone, the structural complexity within the Rengali Province arises from superposition of syn-D_3 shortening structures on initially asympathetically oriented inherited cylindrical D_1-D_2 folds. Hydrous fluid channeling causing greenschist facies metamorphism and quartz vein emplacement accompanied D_3 as the step-over zone was dilational in nature.

1. Introduction

Interpretation of structures in regional-scale strike-slip shear zones is inherently complex. Extension and shortening are invariably associated with these zones along step-overs and bends (Aydin and Nur, 1982, 1985; Cunningham and Mann, 2007), and may be superposed on each other if the step-over zone migrates along strike (Wakabayashi et al., 2004; Wakabayashi, 2007). The structural set-up may be further complicated by superposition of deformation associated with strike-slip movement on pre-existing basement structures (e.g. Beydoun, 1999; Mann et al., 2007; Barreca and Maesano, 2012). Alternatively, structures related to a later orogeny may also be superposed on earlier transpressional features (e.g. Goscombe et al., 2003). Failure to discriminate strike-slip related features from earlier and later structures in such domains may lead to misinterpretation of the strain field related to the strike-slip deformation, and the tectonic regime.

In the eastern Indian shield, a major strike-slip shear zone has been postulated along the terrane boundary between the Archaean Singhbhum Province (southern part of the Singhbhum Craton) and the Proterozoic Eastern Ghats Belt (EGB) (Fig. 1, inset). The zone consists of a WNW–ESE trending system of dextral strike-slip faults, with an estimated displacement in excess of 100 km (Nash et al., 1996), that enclose a structurally complex lithotectonic domain called the Rengali Province (Crowe et al., 2003). However, shortening and thrusting have also been reported from this region (e.g. Banerji et al., 1987; Ghosh et al., 2010) leading to confusion about the nature of the contact. The tectonic affiliation of the Rengali Province, which is described as a domain distinct from the Singhbhum Province and the Eastern Ghats Belt, is also uncertain (Crowe et al., 2003).

In this study, we have remapped a major part of the Rengali Province on a 1:50,000 scale. Our field investigations, when combined with microstructural, thermobarometric and published geochronological data, indicate that the entire Rengali Province is essentially a fragment of the Bastar Craton that has undergone internal rotation of ~120° during the dextral shearing event as part of an evolving dilational step-over system. It is demonstrated that much of the confusion about the nature of the boundary has resulted because a Cambro-Ordovician strike-slip-related deformation has been superposed on a late Archaean fold system, resulting in complex structural geometries that developed as the propagating strike-slip system interfered with inherited structures in the continental crust.

* Corresponding author. Tel.: +91 3222 283370; fax: +91 (0)3222 255303.
E-mail addresses: misrasurajit@gmail.com (S. Misra), saibl@gg.iitkgp.ernet.in, saibl2008@gmail.com (S. Gupta).

0191-8141/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jsg.2013.11.004

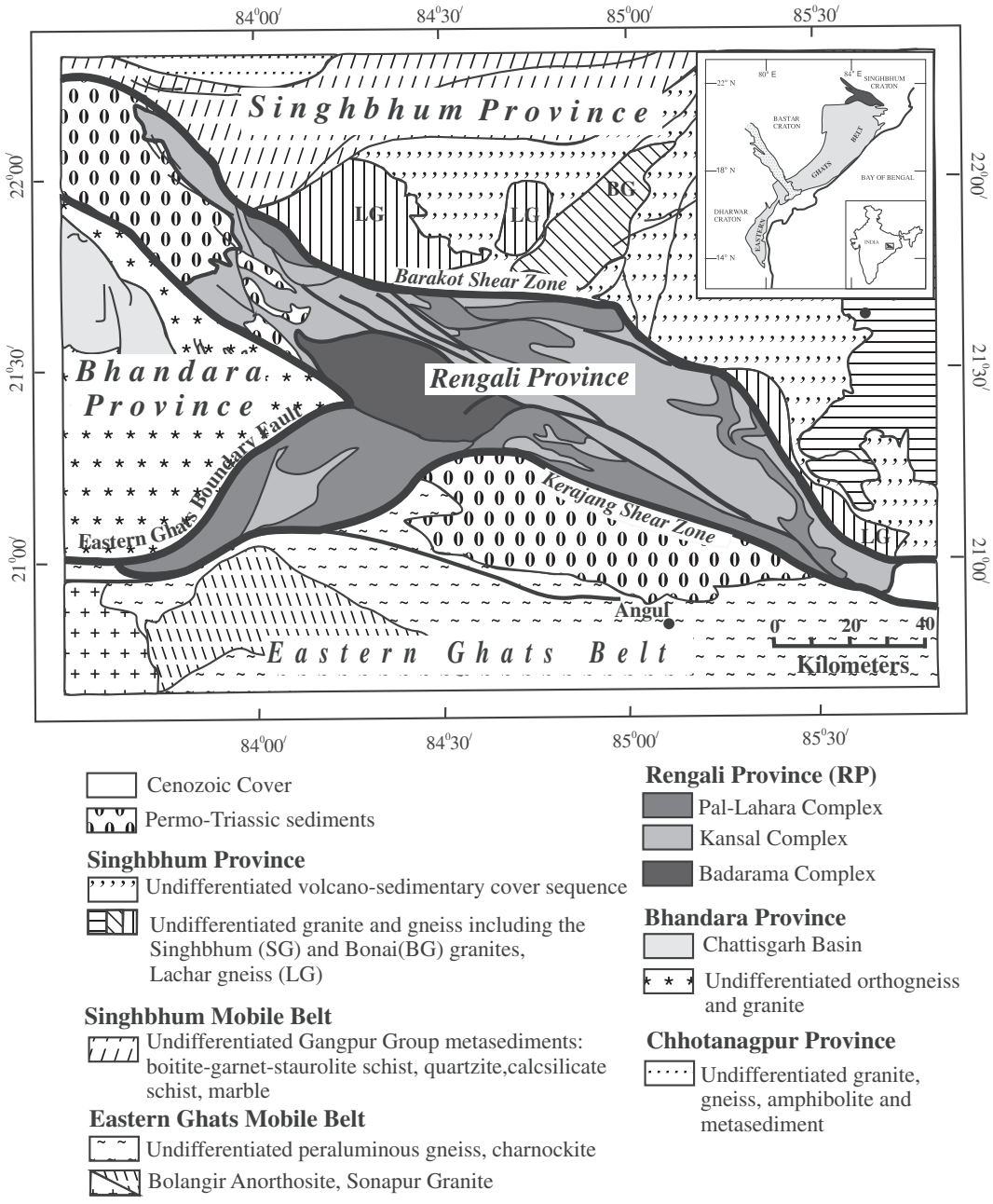

Fig. 1. Geological map of the Rengali Province, slightly modified after Crowe et al. (2003). Note that the 'Bhandara Province' of Crowe et al. (2003) corresponds to the Bastar craton in this study, as shown in the inset map. The two inset maps show the location of the Rengali Province in India, and its position with respect to the Eastern Ghats Belt, Bastar and Singhbhum Cratons.

2. Geological setting

2.1. Tectonic background

In the Neoproterozoic time, the eastern Indian shield was the site of a major tectonic event that involved the Eastern Ghats Belt (EGB) and the Archaean Indian craton. The EGB is a Proterozoic granulite facies terrane that was once contiguous with the Rayner Province of East Antarctica, and thereafter collided with the Indian craton in the late Mesoproterozoic to Neoproterozoic time (~980–930 Ma; Mezger and Cosca, 1999; Dobmeier and Raith, 2003; Dasgupta and Sengupta, 2003). The foreland of the collisional front was constituted of the Dharwar and Bastar Cratons to the west of the EGB, and the Singhbhum Craton to its north (Fig. 1; Upadhyay, 2008; Gupta, 2012). During the amalgamation, the EGB was thrust westward onto hornblende granites, orthogneisses and dolerite dykes of the Bastar Craton resulting in shortening deformation and attendant metamorphism of the cratonic footwall (Gupta et al., 2000; Bhadra et al., 2004; Biswal et al., 2007). In contrast to the western boundary between the EGB and the Bastar Craton, the northern boundary of the EGB with the Singhbhum Craton (Archaean granitoids and granite gneisses overlain by greenschist facies volcano-sedimentary sequences) is more complex. Based on evidence of both shortening (e.g. Banerji et al., 1987)