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Magnetotelluric imaging across the tectonic structures in the eastern segment of the Central Indian Tectonic Zone: Preserved imprints of polyphase tectonics and evidence for suture status of the Tan Shear

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A B S T R A C T

The Central Indian Tectonic Zone (CITZ), a major tectonic feature extending across the Indian subcontinent, was formed by the accretion of the cratonic domains in the north and south blocks of peninsular India during the Proterozoic. It is characterized with prominent shear/fault zones and granulite belts that carry the evolutionary history of the central Indian region. This study presents the two-dimensional resistivity structure of the hitherto least studied eastern segment of the mega lineament in the Indian subcontinent. Magnetotelluric (MT) data along the Rajnandgaon-Bareli profile, which extends from the southern margin (Central Indian Shear-CIS) to the northern limit (Narmada-Son Lineament-NSL) of the CITZ, were used to investigate the resistivity character of the crust and shallow upper mantle. The study imaged conductive to moderately conductive structures, which show correlation to the various shear/faults and granulitic belts mapped in the region, interspersed in a resistive background. An upper crustal isolated conductor was observed below the Bhandra – Balaghat Granulite belt, which is exposed along the CIS. A vertical moderately conductive structure noticed in the middle to upper mantle depths under the Ramakona-Katangi Granulite (RKG) belt and this is interpreted as fault/shear zone that acted as the channel/pathway for the emplacement of parental magma of the RKG rocks. A more interesting feature in the MT model is a north dipping conductive horizon extending from the upper crust to the Moho. This feature shows further extension into the upper mantle as a subvertical moderately conductive zone and can be traced onto the surface mark of the Tan Shear, which suggests suture status to this prominent shear zone within the CITZ. Resistivity section also shows mid-lower crustal conductive/moderately conductive horizons under the Deccan trap and NSL, which are produced due to the large-scale magma intrusions into the crust during the Cretaceous-Tertiary Deccan volcanism through the pre-existing weak zones in the CITZ. The conductive to moderately conductive features of the MT model are indicative of the complex tectonic history of the region that range from accretion processes started in the Paleoproterozoic, followed by multiple metamorphic and deformation cycles in different geological times, to the Late Cretaceous volcanism.

1. Introduction

The Central Indian Tectonic Zone (CITZ), which extends from west coast to northeastern margin of India (inset, Fig. 1), is recognized as the largest intra-plate tectonic feature of the Indian continental lithosphere. The E-W to ENE-WSW oriented CITZ was originally formed as a suture zone between the southern (consists of Bastar, Singhbhum and Dharwar cratons) and northern (consists of Bundelkhand and Aravalli cratons) lithosphere blocks of the present Indian peninsular shield during the Paleoproterozoic (Radhakrishna and Naqvi, 1986; Acharyya, 2003; Roy and Prasad, 2003; Mohanty, 2010; Radhakrishna et al., 2013). Periodic reactivation of the CITZ, through major tectonothermal events and differential crustal movements, is recorded along its strike (Sheth and Chandrasekharam, 1997; Sarkar et al., 1986; Acharyya and Roy, 2000; Acharyya, 2003; Bhowmik et al., 2012; Chattopadhyay et al., 2015) and still persists as shown by the significant crustal seismicity along the CITZ in the recent past (Rajendran and Rajendran, 1999; Rao et al., 2002; Abdul Azeez, 2016). Thus the formation and evolution of the peninsular Indian shield as a whole,

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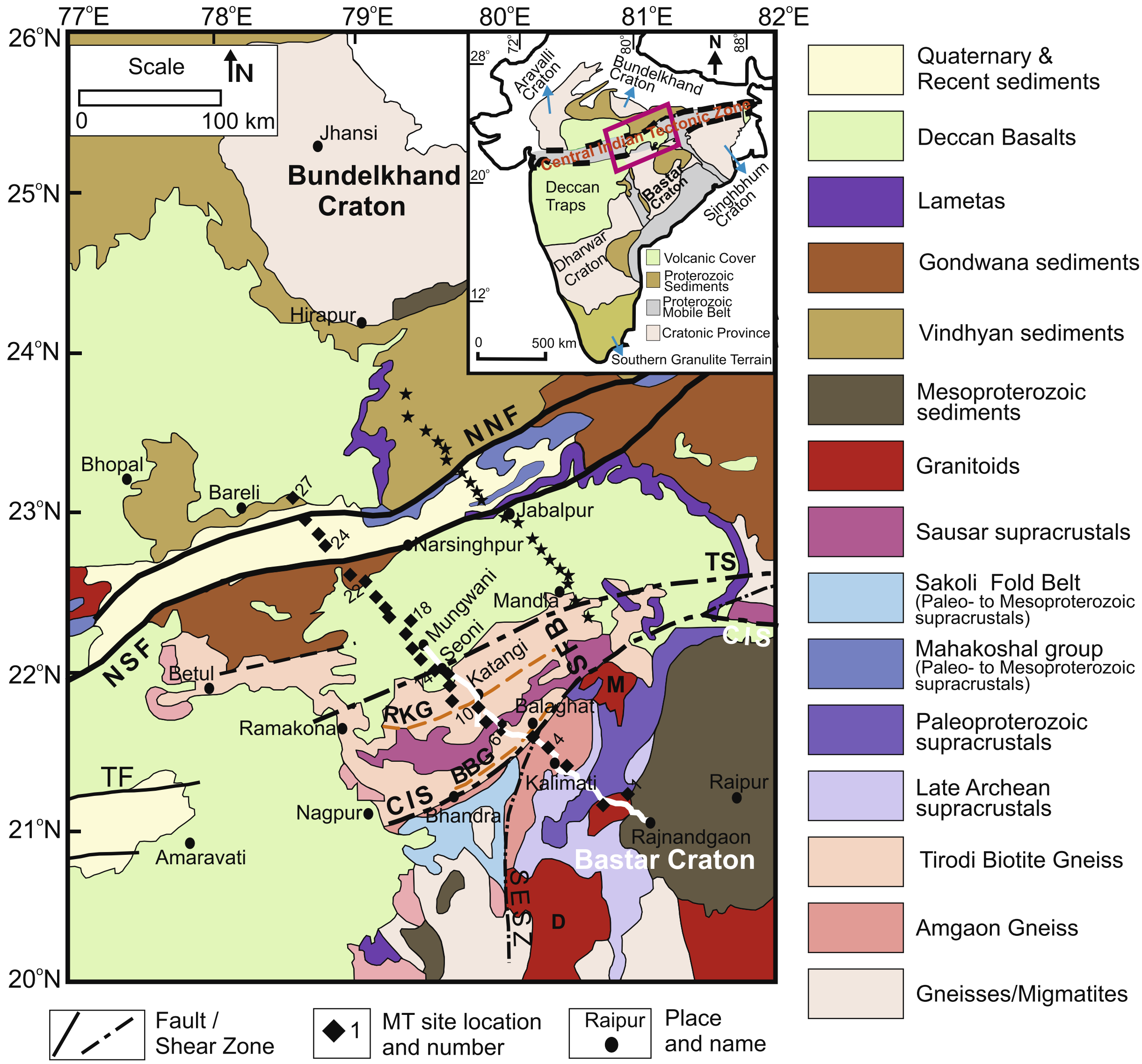

Fig. 1. Geological map of the eastern segment of the Central Indian Tectonic Zone and its neighborhood (modified from Acharyya and Roy, 2000; Roy et al., 2001; Mohanty, 2015), with locations of magnetotelluric sites along the present MT profile (black diamond symbols) and the previous MT study (black star symbol) of Gokarn et al. (2001). The white line represents the previous geophysical profile across the Central Indian Shear (CIS) along which gravity modeling (Rajnandgaon-Mungwani) and seismic reflection (Kalimati-Seoni) studies were carried out. Inset: Simplified geological map of peninsular India showing different Archean cratons and Proterozoic mobile belts (modified from Mohanty, 2015) and location of present study area (magenta box). BBG – Bhandra-Balaghat Granulite; D – Dongargarh igneous suite; M – Malanjkhand igneous suite; NNF – Narmada-Son North Fault; NSF – Narmada-Son South Fault; RKG – Ramakona-Katangi Granulite; SESZ – Sakoli East Shear zone; SFB – Sausar Fold Belt; TF – Tapti Fault; TS – Tan Shear. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

but the central Indian region in particular, have extreme association to the CITZ.

The CITZ is bounded to the north by the Narmada-Son Lineament (NSL), which is comprised of the E-W/ENE-WSW trending Narmada-Son North Fault (NNF) and Narmada-Son South Fault (NSF; Fig. 1). The southern limit of the CITZ is identified as the Tapti Fault (TF) and Central Indian Shear (CIS) at its western and central to eastern segments, respectively (Jain et al., 1991; Acharyya and Roy, 2000; Roy and Prasad, 2003; Bhandari et al., 2011). Contrasting tectonic models exist to explain the evolution of the CITZ (e.g. Yedekar et al., 1990; Acharyya and Roy, 2000; Mishra et al., 2000; Roy and Prasad, 2003; Mall et al., 2008; Sarbadhikari and Bhowmik, 2008; Mandal et al., 2013), mainly differing on the subduction polarity, and controversy remains on the location of the suture line between the Bastar and Bundhelkhand cratons involved in the subduction-collision processes. Several studies proposed the CIS as the suture mark between the two cratonic blocks (Yedekar et al., 1990; Jain et al., 1991, 1995; Mishra et al., 2000; Mall et al., 2008; Rao et al., 2011; Mandal et al., 2013) while others designated the CIS as only a ductile shear zone and hinted at the possibility of locating the suture mark further north of the CIS leaving a question on the suture status of the CIS (Bhowmik et al., 1999; Acharyya and Roy, 2000; Acharyya, 2003; Roy and Prasad, 2003; Roy et al., 2006). Crustal structure of the CITZ, particularly along-strike variation of the geophysical structure, has been studied using various deep probing geophysical tools such as reflection/refraction seismic, gravity, and magnetotellurics (Singh and Meissner, 1995; Tewari and Kumar, 2003; Rao et al., 2004; Patro et al., 2005; Naganjaneyulu and Santosh, 2010, 2011; Abdul Azeez et al., 2013; Mandal et al., 2013; Patro and Sarma, 2016; references therein). However, it is apparent that the crustal geophysical structure of the central-eastern segment of the CITZ (bounded by NSL and CIS) is poorly studied as compared to its western segment.