Available online at www.sciencedirect.com

SCIENCE DIRECT®

Journal of Asian Earth Sciences 26 (2006) 437–448

Journal of Asian Earth Sciences

www.elsevier.com/locate/jaes

Crustal configuration of the Dharwar craton, India, based on joint modeling of regional gravity and magnetic data

G. Ramadass, I.B. Ramaprasada Rao*, D. Himabindu

Center of Exploration Geophysics, Osmania University, Hyderabad 500 007, India

Received 26 September 2003; revised 21 September 2004; accepted 13 October 2004

Abstract

Regional gravity and magnetic investigations were conducted along a 600 km transect across the northern part of the Dharwar craton in the Precambrian Indian peninsular shield from Vasco-da-gama (latitude 15°23′40″N and longitude 73°48′55″E) to Jadcharla (latitude 16°41′40″N and longitude 78°08′18″E). Joint modeling of the two data sets was carried out utilizing GM-SYS (Geosoft) software assuming a four-layer model.

A tectonic re-classification of the craton is proposed, prompted by the location of four inferred deep-seated faults, into the western and eastern Dharwar Blocks with an intervening upthrown block. This classification is at variance with the current perceptions of the configuration of the Dharwar craton, some of which hold that the craton consists of only two sub-cratons, an eastern and a western, divided by the Chitradurga thrust fault. However, in the present study, this thrust fault is found to extend no deeper than the basement peninsular gneisses. Furthermore, according to the proposed classification, the thrust fault falls within the intervening block that forms the divide between the sub-units of the craton rather than representing a tectonic boundary.

In addition, twenty-six near surface geological members in the region (supracrustals) consisting mainly of schists and younger granites were identified along the transect and modeled for the representative near-surface crustal configuration of the craton.

Keywords: Vasco-da-gama–Jadcharla transect; Joint modeling; Regional gravity and magnetic investigations; Dharwar Craton–Western; Intervening and Eastern blocks

1. Introduction

The Archaean–Proterozoic Dharwar craton in the Precambrian Indian Peninsular Shield extends over 350,000 km^2 in area (Ramam and Murty, 1997). It is characterized by a complex geological history. While the southern and central parts of the craton are well investigated, the northern part received relatively lesser attention. The general geology of the craton consists of mainly three members—peninsular gneisses, schist belts and Closepet granites—related to one another in complex assemblages (Radhakrishna and Vaidyanathan, 1997). Several studies, notably geological (Naqvi and Rogers, 1987; Rajamani, 1990; Chadwick et al., 2000), gravity (Qureshy et al., 1967; Kaila and Bhatia, 1981; Mishra and Prajapati, 2003), deep seismic soundings (DSS) (Kaila et al., 1979; Reddy et al., 2000), tomographic studies (Srinagesh and Rai, 1996; Gupta, 2003), magneto-telluric investigations (Gokarn et al., 1998), petrophysical studies (Ramadass et al., 2002), and heat flow measurements (Gupta, 1982) contributed immensely in reconstructing the geological history of the Dharwar craton.

Rajamani (1990) proposed two broad sub units within the craton—the eastern Dharwar craton lying to the east of the Closepet batholith (Fig. 1) and the western Dharwar craton lying to its west. However, while the sub units of the craton are generally recognized, there is some disagreement on the exact location and nature of the boundary separating them. Essentially, two different boundaries have been proposed. Naqvi and Rogers (1987) suggested that the Closepet granitic batholith formed the boundary between the eastern and western Dharwar cratons. However, the nature of the Closepet batholith itself is open to debate: while

* Corresponding author.
E-mail address: ibrrao@pol.net.in (I.B. Ramaprasada Rao).

1367-9120/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.jseaes.2004.10.005

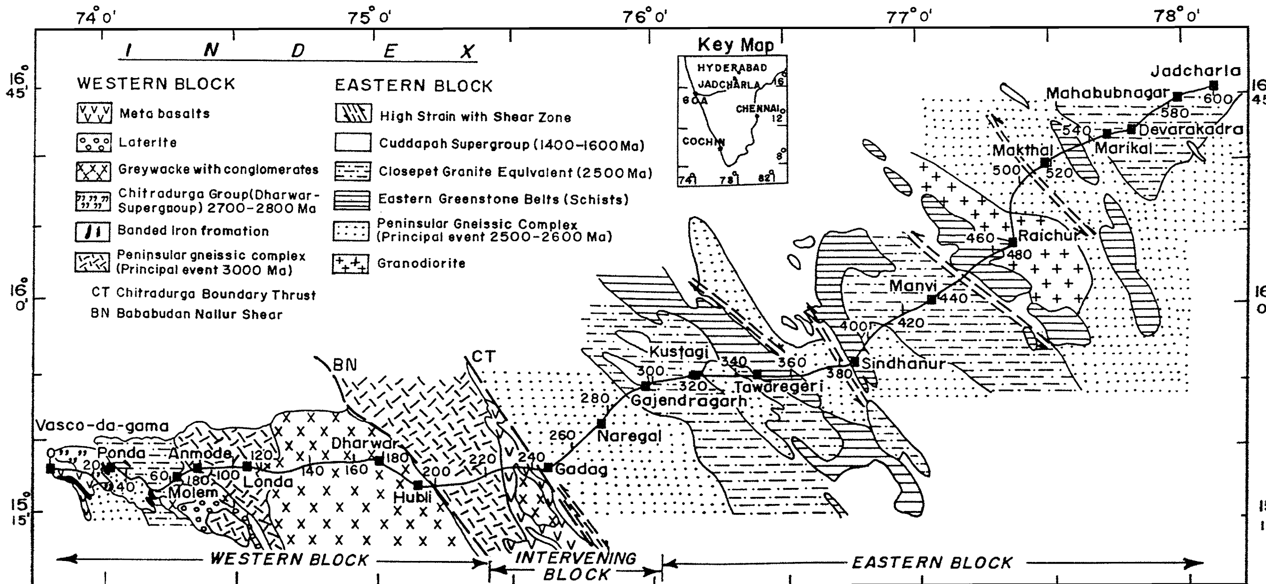

Fig. 1. Geology and layout map along the Vasco–Jadcharla transect (after Chadwick et al., 2000).

Swaminath et al. (1976) and Ramakrishnan et al. (1976) have opined that it represents a major geosuture, Narayanaswamy (1970) presented it as a geo-anticlinal ridge.

On the other hand, Drury and Holt (1980), Drury et al. (1984) and Chadwick et al. (2000) have suggested that the Chitradurga shear zone (CT in Fig. 1) divides the craton into the eastern and western blocks. Similar inferences were arrived at from deep seismic sounding (DSS) studies by Kaila et al. (1979) and Project Vasundhara (Geological Survey of India, 1994). More recently, from analysis of seismic wave velocities, Reddy et al. (2000) also reported that the upthrust zone along the Chitradurga boundary thrust fault marked this major contact.

Lack of any consensus on the configuration of the craton emphasizes the need for investigations oriented towards understanding the tectonics and the deep continental structure in the Dharwar craton. With this in mind, the Vasco–Dharwar–Hubli–Gadag–Raichur–Jadcharla transect (Fig. 1), which cuts across the northern part of the Dharwar craton, was identified for regional gravity and magnetic surveys. This transect traverses all the major geological formations of the craton, viz., peninsular gneisses, schists and the younger granites. These formations have respective ages of 3400–3000 million years (Ma), 2900–2600 and 2600–2500 Ma (Beckinsale et al., 1980; Taylor et al., 1984; Bhaskar Rao et al., 1991).

2. The study area and its geology

The 600 km Vasco (latitude 15°23′40″N and longitude 73°48′55″ E)—Jadcharla (latitude 16°41′40″N and longitude 78°08′18″E) transect (Fig. 1) runs in an approximately E–W direction. It extends across three states—Andhra Pradesh, Karnataka and Goa. Jadcharla lies 85 km southwest of Hyderabad, India, along National Highway No.7 and 15 km NE of Mahboobnagar town, Mahboobnagar district, Andhra Pradesh, India (inset in Fig. 1). As part of the present study, an updated geological map along the transect (Fig. 1) was prepared using data from various sources. We compiled the geology along the transect using a 1:20,00,000 scale geological map of the area prepared under Project Vasundhara (Geological Survey of India, 1994), the 1:5,00,000 (1981) and 1:1,25,000 (1996) scale maps prepared by the Geological Survey of India (GSI) (1981), and the geological map after Chadwick et al. (2000). Greater detail in the geology of the area was achieved by incorporating inferences drawn from the results of field investigations, which were carried out with a station interval of 500 m (where necessary).

The peninsular gneissic complex can be divided into an older tonalitic/trondhjemitic gneissic complex (3300–3000 Ma) and a younger gneissic complex (3000–2600 Ma). While the former is seen almost entirely to the west of the Chitradurga thrust fault passing through Gadag, the latter, consisting of reworked and remobilized gneisses of granodioritic and granitic composition, is seen mostly east of Gadag (Radhakrishna and Vaidyanathan, 1997).

The widespread schist belts and numerous enclaves of a variety of volcano-sedimentary material of the Dharwar supergroup (2900–2600 Ma) lie unconformably over the peninsular gneissic complex (Swaminath et al., 1976). An interesting feature observed in the schist belts of the Dharwar craton is that they are generally associated with shear zones (Chadwick et al., 2000). While the Makthal, Raichur and Sindhanur schist belts have shear zones on their western side, the Kushtagi and Gadag schist belts have shear