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Seismic evidence of crustal low velocity beneath Eastern Ghat Mobile Belt, India

Kuntal Chaudhuri [a,*], Kajaljyoti Borah [a], Sandeep Gupta [b]

[a] Department of Earth Sciences, Indian Institute of Science Education and Research Kolkata, Mohanpur 741 246, India
[b] CSIR National Geophysical Research Institute, Hyderabad 500 007, India

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ABSTRACT

The Eastern Ghat Mobile Belt (EGMB), a tectonically active area extends along the eastern margin of Peninsular India, is divided into three provinces, namely, Eastern Ghat Province, the Jeypore Province, and the Krishna Province. The Ongole domain of Krishna Province is a seismically active region that has experienced four moderate earthquakes of magnitude $\geqslant$5.0, of which largest one is of magnitude 5.4 occurred on 27th March 1967. The crustal shear wave velocity structure in the Eastern Ghat Mobile Belt has been investigated using joint inversion of receiver functions and Rayleigh wave group velocity at 5 locations in the study region. The results show crustal thickness variation from 37 to 42 km and average shear velocity variation from 3.67 to 3.78 km/s in the study region. A low velocity layer of variable thickness and velocities 3.54–3.7 km/s) is also observed in the region. The low velocity layer in most of the stations is observed at a depth of ~20 km. This low velocity layer may be due to the presence of fluid in the crust, which also be one of the causes of the intraplate earthquakes in the study region.

1. Introduction

The Eastern Ghats Mobile Belt (EGMB) is a NE-SW trending arcuate Precambrian fold belt of high grade rocks along the east coast of India (Fig. 1). It is a highly eroded part of an extensive orogenic belt delineating the eastern boundary of the archean cratons of India. The belt consists of supracrustals of charnockites and enderbites, which are products of highly deformed and multiply metamorphosed protolith. The presence of sapphirine bearing granulites predicts the occurrence of ultra-high metamorphism (UHT) which probably has been caused due to crustal delamination. The striking similarity between the rocks exposed in the EGMB and Antarctica, particularly in the Enderby Land area (Napier and Rayner Complexes) clearly shows the association of the EGMB with the South West United States and East Antarctica (SWEAT) and the involvement of EGMB in the separation of two major supercontinents, Columbia (Rogers and Santosh, 2002; Zhao et al., 2002, 2004) and Rodinia (Li et al., 2008) and it has been unanimously agreed upon by the scientific community (e.g., Rao et al., 2011; Kumar and Leelanandam, 2008; Vijaya Kumar et al., 2011).

Most of the geophysical anomalies viz., seismic velocity, gravity, heat flows and seismicity are more pronounced in the mobile belts. The crustal velocity structure and Moho configuration are the important parameters to understand the tectonic process and the evolution of any region. They can be used to calculate the stress generation and to understand the seismicity of intraplate regions. Mandal (1999) has evaluated the amount of stress generated due to crustal density/velocity heterogeneities (subsurface load) in various parts of the Indian shield and demonstrated its significance in the seismicity of the region. Reddy (1995) also indicated the importance of crustal thickness and velocity distribution in stress generation with reference to the Indian shield.

The behavior of the continental crust under stress depends chiefly on the temperature and the duration of the stresses. The hotter the crust, the more it behaves like a ductile solid deforming by plastic flow (Condie, 2005). If it is cool, it behaves like an elastic solid deforming by brittle fracture and frictional gliding (Rutter and Brodie, 1992). The distribution of strength with depth in the crust varies with the tectonic setting, the strain rate, the thickness and composition of the crust, and the geotherm. The brittle-ductile transition corresponding to an average surface heat flow of 50 mWm^{-2} is around a 20-km depth, which corresponds to the depth limit of most shallow earthquakes. The brittle-ductile transition occurs around a 20-km depth in the rift, whereas in the cooler and stronger Proterozoic shield, it occurs around 30 km. In general,

* Corresponding author.
E-mail address: kuntal11012@gmail.com (K. Chaudhuri).

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