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Deep resistivity sounding studies in detecting shear zones: A case study from the southern granulite terrain of India

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Abstract

The resistivity signatures of the major crustal scale shear zones that dissect the southern granulite terrain (SGT) of South India into discrete geological fragments have been investigated. Resistivity structures deduced from deep resistivity sounding measurements acquired with a 10 km long Schlumberger spreads yield significant insights into the resistivity distribution within the E–W trending shear system comprising the Moyar–Bhavani–Salem–Attur shear zone (MBSASZ) and Palghat–Cauvery shear zone (PCSZ). Vertical and lateral extensions of low resistivity features indicate the possible existence of weak zones at different depths throughout the shear zones. The MBSASZ characterized by very low resistivity in its deeper parts (>2500 m), extends towards the south with slightly higher resistivities to encompass the PCSZ. A major resistivity transition between the northern and southern parts is evident in the two-dimensional resistivity images. The northern Archaean granulite terrain exhibits a higher resistivity than the southern Neoproterozoic granulite terrain. Though this resistivity transition is not clear at greater depths, the extension of low resistivity zones has been well manifested. It is speculated here that a network of crustal scale shear zones in the SGT may have influenced the strength of the lithosphere.

Keywords: Deep resistivity sounding; Shear zones; Southern granulite terrain

1. Introduction

The South Indian shield consists of fragments of different crustal blocks joined along or bounded by Proterozoic mobile belts/shear systems. Recently, these crustal scale shear zones in the shield have attracted wide attention owing to their vital role in reconstructing the Precambrian evolution of south India. While geological studies can provide information on the surface manifestations of the shear zones, only geophysical investigations can provide significant depth information, especially regarding the nature and extension of fault zones at different depths. The efficacy of deep resistivity sounding (DRS) studies in investigating the conductive nature of shear zones has been previously reported by Singh et al. (2003), as part of an integrated geophysical/geological investigation of the tectonics of the high grade granulite terrain of South India (Reddy et al., 2000). The associated mineralogy, seismic stresses, fluids, etc. influence the various physical parameters of the shear zones at depth. The N–S trending geo-transect from Kuppam to Palani crosses all the diverse and highly metamorphosed crustal fragments in the SGT. In the present study, we concentrate on the resistivity signatures of the shear systems in the southern part of this Kuppam–Palani geo-transect (Fig. 1). DRS and magnetotelluric sounding (MTS) studies have documented a highly conductive signature for the shear zones, with a steep structure to deep crustal depths (Singh et al., 2003; Harinarayana et al., 2003). The correlation of major shear systems, a large number of deep faults and seismicity with SGT indicate that tectonic activity is continuing (Grady, 1971). A mechanically weakened lithosphere beneath the SGT (Stephen et al., 2003) might have some role in ongoing tectonic processes.

2. Geological setup

The southern granulite terrain of the Indian shield, consisting of exhumed Precambrian lower crust, provides a window for observing ancient crusts reflecting a wide spectrum of metamorphic events within a diverse set of crustal blocks. The SGT contains granite-greenstone rocks in its northern part,

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