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Possible detachment zone in Precambrian rocks of Kanjamalai Hills, Cauvery Suture Zone, Southern India: Implications to accretionary tectonics

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ABSTRACT

Existence of a possible detachment zone at Elampillai region, NW margin of Kanjamalai Hills, located in the northern part of Cauvery Suture Zone (CSZ), Southern India, is reported here for the first time. Detailed structural mapping provides anatomy of the zone, which are rarely preserved in Precambrian high grade terranes. The detachment surface separates two distinct rock units of contrasting lithological and structural characters: the upper and lower units. The detachment zone is characterized by a variety of fold styles with the predominance of tight isoclinal folds with varied plunge directions, limb rotations and the hinge line variations often leading to lift-off fold like geometries and deformed sheath folds. Presence of parasitic folding and associated penetrative strains seem to be controlled by differences in mechanical stratigraphy, relative thicknesses of the competent and incompetent units, and the structural relief of the underlying basement. Our present study in conjunction with other available geological, geochemical and geochronological data from the region indicates that the structures of the detachment zone are genetically related to thrust tectonics forming a part of subduction–accretion–collision tectonic history of the Neoproterozoic Gondwana suture.

1. Introduction

In the past two decades, much emphasis has been paid to understanding the natural deformation of rocks in terms of shear zone systems (Ramsay, 1980). Localization of strain into high strain zones is a common feature in such shear zones, which are also described as ductile deformation zones (Mitra, 1978). High strain zones with typical structures like box folds, lift-off folds, and refolded sheath folds are specially described as detachment zones (Mitra, 2003). Detachment folds or fault zones provide direct information about the processes involved in transporting the thrust sheets to higher crustal levels (Gray, 1995). A detachment zone commonly develops when a layer of rock deforms above a bedding-parallel detachment surface or décollement, which are cored by incompetent, often disharmonically folded strata (Dahlstrom, 1970; Laubscher, 1977; Jamison, 1987). Recently, Mitra (2003) has defined that detachment folds are characterized by the termination of a parallel fold at a basal detachment within a ductile unit. These structures form in stratigraphic packages with high competency contrasts among units. The competent upper units exhibit parallel fold geometries, whereas the weak lower unit displays disharmonic folding and significant penetrative deformation. The major mechanism in detachment zones is the transportation of deep crustal materials to the shallow crustal levels, referred to as the tectonic unroofing of high grade terrains. The driving force in such cases has been widely reported to be from a variety of geodynamic settings.

Detachment zones are rarely exposed in case of high grade metamorphic regions unlike in sedimentary terrains, where they are mostly well preserved. The best examples are in the Jura Mountains, associated with middle Triassic evaporates (Noack, 1995). It is well known that identifying a detachment zone in Precambrian high grade terranes is a challenging task because of multiple deformational events. During our recent regional geological traverses, we have come across a possible detachment zone at the NW margin of Kanjamalai Hills, located on the northern boundary of Cauvery Suture Zone (CSZ), Southern Granulite Terrane (SGT), Southern India. We have attempted a detailed structural analysis of partly exposed detachment zone and documented a well exposed structural transition from less deformed to intensely

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deformed high grade granulite facies rocks into a possible detachment zone of mylonitic rock units associated with intensely and complexly folded structural units. Our new results of structural analysis are examined in the light of the regional structural architecture of the Kanjamalai Hills and the SGT and their significance in the development of Gondwana suture. In this contribution, we present a variety of structural features that are associated with the detachment zone and suggest that these are possibly related to Precambrian accretionary tectonics. Our study focuses entirely on field and laboratory interpretation of the structures and deformation mechanisms within the zone of detachment, and its relationship with thrusting and emplacement mechanisms at high grade granulite facies conditions. We also emphasize on the implications of our study in understanding the tectonic evolution of the SGT, involving subduction–accretion–collision processes envisaged during the break up and amalgamation of the Gondwana supercontinent.

2. Regional geology

Recent geological and geophysical studies have established that the Cauvery Shear Zone (CSZ) extends in an east–west fashion (Fig. 1) for about 400 km with a width of ~70 km, and is a major tectonic zone separating the late Archean granulite blocks to the north and Neoproterozoic Madurai block to the south within the Southern Granulite Terrane (SGT) (Drury and Holt, 1980; Drury et al., 1984; Chetty et al., 2003, 2006 and the references there in). The CSZ is a Precambrian suture zone forming part of a major continental collisional suture developed through southward subduction (Chetty et al., 2006 and the references therein; Santosh et al., 2009). The CSZ has also been demonstrated as a crustal-scale 'flower structure' that formed as a result of Neoproterozoic dextral transpression resulting from oblique collisional processes (Chetty et al., 2003; Chetty and Bhaskar Rao, 2006a, 2006b), similar to the structures described from other global collisional belts (e.g., Abd-El Wahed and Kamh, 2010; Li et al., 2010).

The major rock types in the region include charnockites, granitoids, migmatitic gneisses and anorthosies in the order of abundance. The granitoids belong to Neoproterozoic age and occur in the form of a domal structure around Sankaridurg, while highly stretched and fragmented small plutons occur along the Mohanur–Tiruchirapalli Shear Zone (MTSZ). Several recent studies have also documented the presence of high pressure granulites within the CSZ with pressures in the range of 12–20 kb (Shimpo et al., 2006; Collins et al., 2010; Sajeev et al., 2009; Santosh et al., 2010; Anderson et al., 2012) as well as ultrahigh temperature mineral assemblages (Tsunogae and Santosh, 2004, 2007; Tsunogae et al., 2008; Santosh and Kusky, 2010; Shimizu et al., 2010). The presence of ophiolites in the south eastern part of the CSZ has been recently described with a combination of field, petrological and geochemical characteristics, developed within a suprasubduction zone tectonic setting (Yellappa et al., 2010, 2012; Chetty et al., 2011; Santosh et al., 2012). The U–Pb zircon geochronology has correlated the ophiolite formation with the Neoproterozoic subduction tectonics and the final collisional metamorphism during Cambrian (Sato et al., 2011). Santosh et al. (2009) recently proposed a Pacific-type orogeny culminating in the Himalayan-style

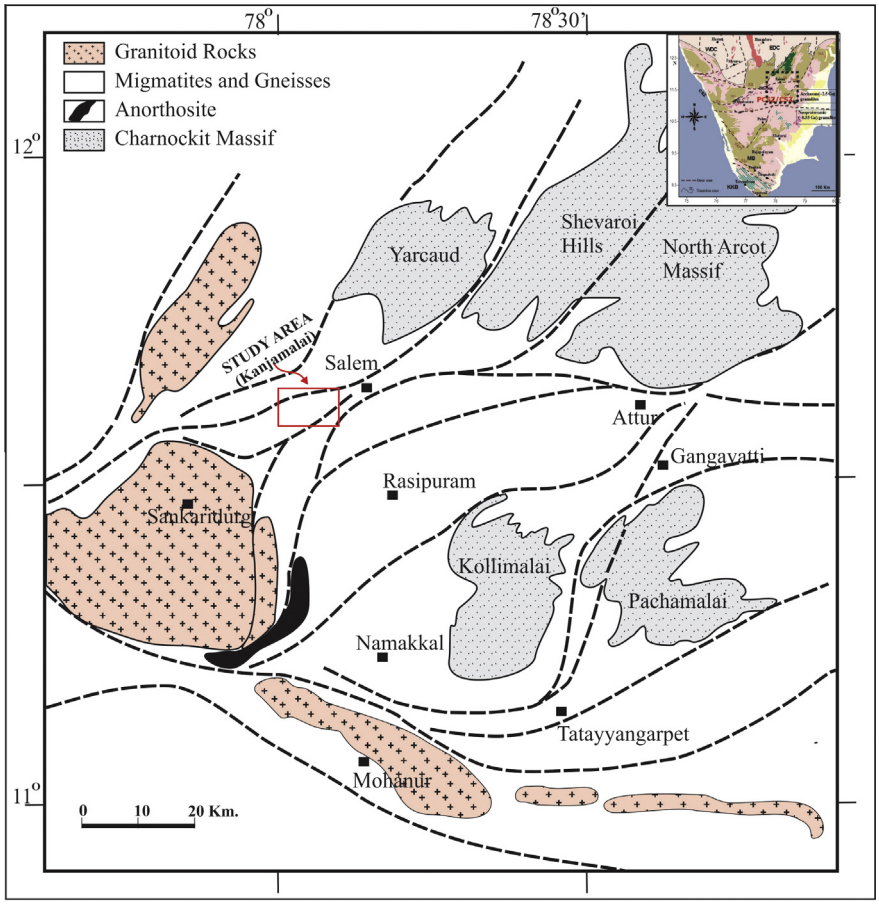

Fig. 1. Regional map showing the eastern part of CSZ showing study area with sigmoidal shear zones joined at Northern and Southern major EW shear zones. Major lithology is marked in the figure.