Proceedings of the IGCP-440 and LEGENDS International Symposium and Field Workshop on "The Role of Sri Lanka in Rodinia and Gondwana Assembly and Break-up", March-April 2003, Centenary Publication, Geological Survey & Mines Bureau, Sri Lanka, (K.V.W. Kehelpannala, Ed.) pp. 33-36

The Cauvery Shear Zone, Southern Granulite Terrain, Southern India: Evidence for Neoproterozoic Transpressional Tectonics

T.R.K. Chetty and Y.J. Bhaskar Rao
National Geophysical Research Institute, Hyderabad-500 007, India
E.mail: chetty1949@yahoo.com

Transpressional belts occur on a wide range of scales with extreme heterogeneous deformation in the earth's lithosphere. They are common in oblique subduction margins, restraining bends of transform and other continental strike-slip displacement zones. Precambrian high-grade terranes with their constituent crustal scale networks of ductile shear zones have been viewed in terms of two important scenarios: (i) exposed deep sections of ancient orogenic belts, and (ii) manifestation of far-field plate tectonic processes (Drury et al., 1984). As well known, the shear zones occur in the form of anastomosing network enveloping the less deformed rock units. The strain partitioning along the shear belts reflect a series of complex deformational processes.

The Southern Granulite Terrain (SGT) occurring in the southern part of the Indian shield has been divided into discrete tectonic blocks separated by a network of Proterozoic shear zones (Drury and Holt, 1980; Gopala Krishnan, 1994; Chetty, 1996). The most prominent of these form a crustal-scale network of shear belts along an east-west tract of ~350 km x 70 km described collectively as the Cauvery Shear Zone (CSZ). The CSZ separates the Archean Dharwar Craton to the north and the Proterozoic granulite blocks to the south (Fig.1). The CSZ has been interpreted by different authors as: (i) a dextral transcurrent shear zone considering the rotation of N-S fabrics of the Dharwar craton in the low-grade terrain to near east-west disposition along the Moyar-Bhavani shear zone (Drury and Holt, 1980) (ii) a collapsed marginal basin, (Drury and Holt, 1980) (iii) collision zone and cryptic suture based on the occurrence of remnants of oceanic crust with tectonic slices of probable ophiolitic sequences, thrust slices and incorporation of marginal sequences of micro-continents (Gopala Krishnan, 1994), (iv) an analogue of central part of Limpopo mobile belt (Ramakrishan, 1993) (v) an Archaean-Proterozoic terrane boundary (Harris et al., 1994) and (vi) a zone of Palaeo- and Neoproterozoic terrane reworking of Archean crust (Bhaskar Rao et al., 1996). The CSZ is also correlated with the left-lateral Ranatsora shear zone of Madagascar and the interface between Napier Complex and Rayner Complex, Enderby Land of east Antarctica (Chetty, 1995).

Structural interpretation of the CSZ from the Landsat TM data on varied space scales such as 1:1million, 1:250,000 and on 1:50,000 reveal the fabric of major structural features, such as shear zones, broad fold styles, and a variety of structural trends (Chetty et al., 2003). The structural trends mostly represent the metamorphic gneissic foliations that are parallel to lithological contacts in the field. Long, linear belts of distinct topographic and textural

expression constituting closely spaced lineaments on the satellite data are interpreted as major shear zones that are later confirmed in the field. Localization of strain along the shear zones separating domains of contrasting strain characteristics is well reflected in the satellite images. Regional structural observations in the eastern part of the CSZ show sigmoidal shear belts with an average width of ~1 km and sub-vertical planar fabrics, traversing the central region and connecting the marginal shear zones on either side. These shear belts are characterized by mylonites, phyllonites, augen gneisses, high asymmetrical folds, S-C fabrics and profusely developed stretching mineral lineations.

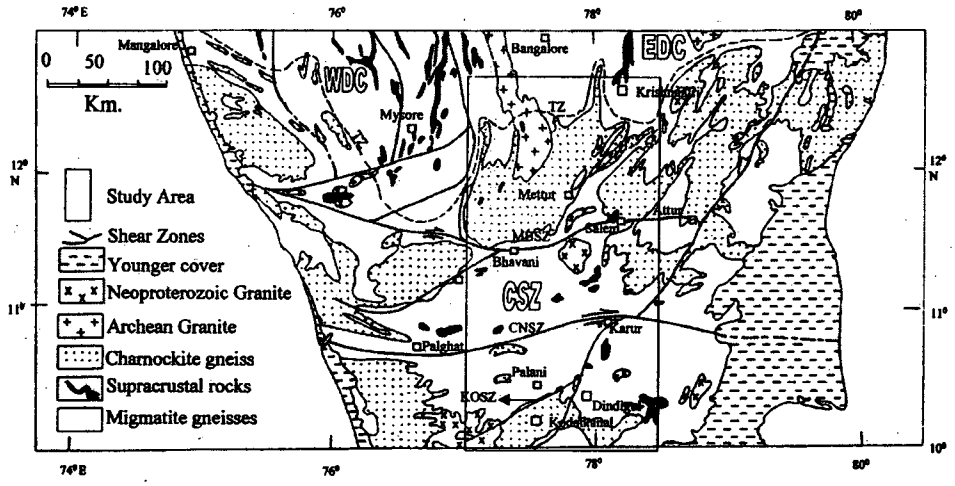

Figure 1. Simplified geological map of part of Southern India (based on 1:2000000 map in GSI & ISRO, 1994) showing the N-S corridor of detailed study. The major shear zones: the Cauvery Shear Zone (CSZ), Moyar-Bhavani (MBSZ), Chennimalai Noyil (CNSZ), Karur Oddanchatram (KOSZ) and prograde metamorphic transition zone (TZ). Also shown are the western and eastern parts of the Dharwar craton (WDC, EDC).

Detailed structural studies along a 100 km wide north-south corridor in the central part of the CSZ reveal a set of major shear zones that are genetically, spatially and temporally interlinked (Chetty et al., 2003). The shear zones from north to south are (i) the Moyar-Bhavani shear zone (MBSZ) constituting the northern boundary of the CSZ, (ii) the Chennimalai Noyil shear zone (CNSZ), (iii) the Dharapuram shear zone (DSZ), (iv) the Devattur-Kallimandayam shear zone (DKSZ), and (v) the Karur-Oddanchatram shear zone (KOSZ). While the MBSZ and CNSZ show near east-west trends for longer distances, the DSZ, DKSZ, and KOSZ exhibit northeasterly trends coalescing with the CNSZ in the east. Our studies suggest that the regional deformation in the SGT can be described in terms of two major episodes: the Palaeoproterozoic and the Neoproterozoic. While large-scale north-verging thrusts accompanied by north-south shortening are ascribed to the Palaeoproterozoic, the Neoproterozoic (750-550 Ma) is characterized by extensive shearing, granite emplace-ment and migmatization. The MBSZ is interpreted as a southerly dipping Palaeoproterozoic frontal thrust and a zone of strong kinematic partitioning.

The shear zones clearly divide the corridor into distinct geologic domains in terms of lithology, structural style, their crust formation and metamorphism of the basement gneisses (Nd model ages, Rb/Sr mica and Sm/Nd garnet ages) (Bhaskar Rao et al., 2003). The attitude of stretching lineations along the CSZ is very complex. While some areas are marked by steeply plunging lineations, others record predominantly gently plunging lineations. There are also examples of the occurrence of both steep and shallow plunging stretching lineations in the same outcrop (Chetty and Bhaskar Rao, 1998). This behaviour of stretching lineations is a reflection of strain variation rather than the indication of tectonic transport.

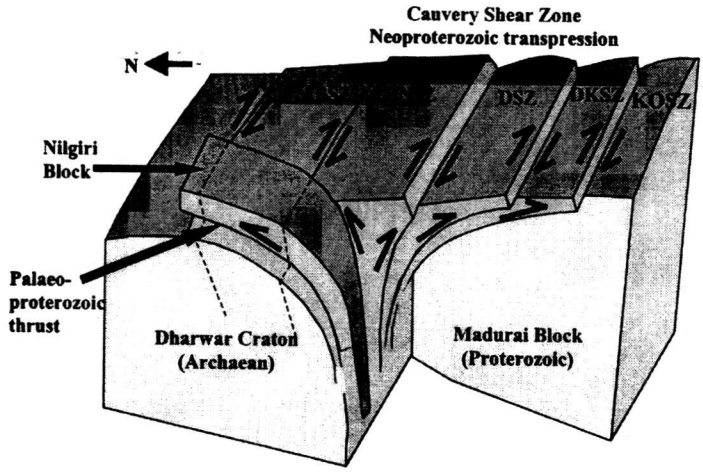

Figure 2. A schematic Block Diagram showing the disposition and geometry of different shear Zones in the CSZ representing the Crustal-scale Flower Structure.

The foliation fabrics along the MBSZ show steep dips to south. The foliations in all the other shear zones in the south show moderate dips to north. Kinematic structural observations such as deflection of foliations, fish-tail and S-C structures, rotation of rigid rolling structures suggest dominantly dextral movements. The disposition, regional geometry, remarkable changes in foliation fabrics, consistent dextral kinematic patterns and the contemporanity of mylonitic fabrics based on Rb-Sr mica ages suggest that the shear zone network in the CSZ could represent a crustal-scale flower structure (Fig. 2) during the Neoproterozoic, related to regional transpression in a convergent tectonic regime. Our observations indicate that the Neoproterozoic deformation was progressively more transpressive with high angle convergence in the eastern part of the CSZ. The available geophysical data such as seismic, magneto-tellurics, gravity and magnetic data (Reddy et al., 2003; Harinarayana et al., 2003; Singh et al., 2003) corroborate the disposition and geometry of the shear zones described here and suggest their extensions, at places, to mantle depths.

References

Bhaskar Rao, Y.J., Chetty, T.R.K., Janardhan, A.S, and Gopalan, K., 1996. Sm-Nd and Rb-Sr ages and P-T history of the Archean Sittampundi and Bhavani layered meta –anorthosite complexes in Cauvery

shear zone, South India: evidence for Neoproterozoic reworking of Archean crust. Contrib. Min. Petrol., 125, 237-250.

Bhaskar Rao, Y.J., Janardhan, A.S., Vijay Kumar, T., Narayana, B.L., Dayal, A.M., Pantulu, G.V.C. and Chetty, T.R.K., 2003. Sm-Nd model ages and Rb-Sr isotopic synthesis of charnockite gneisses across the Cauvery shear zone, Southern India: Implications to the Archean –Neoproterozoic terrane boundary in the Southern Granulite Terrane. Geol. Soc.India. Memoir (in press).

Chetty, T.R.K., 1995. A correlation of Proterozoic shear zones between Eastern Ghats, India and Enderby Land, east Antarctica, based on LANDSAT imagery, India and Antarctica during the Precambrian, In: Yoshida, M and Santosh, M., (eds.) Geol. Soc. India, Memoir 34, 205-220.

Chetty, T.R.K., 1996. Proterozoic Shear Zones in the Southern Granulite Terrain, India, In: M. Santosh & M. Yoshida (eds.), Gondwana Research Group, Memoir 3, 77-89.

Chetty, T.R.K. and Bhaskar Rao, Y.J., 1998. Behaviour of Stretching Lineations in the Salem –Attur Shear Belt, Southern Granulite Terrane, South India. Jour. Geol. Soc. India. 52, 443-448.

Chetty, T.R.K., Bhaskar Rao, Y.J., and Narayana, B.L., 2003. A Structural cross- section along Krishnagiri-Palani corridor, Southern Granulite Terrain, India. Geol. Soc.India, Memoir (in press).

Drury, S.A., Harris, N.B.W., Reeves-Smith, G.J. and Wightman, R.T. 1984. Precambrian tectonics and crustal evolution in South India. Jour. Geol. Soc.India, 92, 3-20.

Drury, S.A., and Holt, R.W., 1980. The tectonic framework of the south Indian craton: A reconnaissance involving Landsat imagery, Tectonophysics, 65, T1-T15.

Gopala Krishanan, K., 1994. An Overview of Southern granulite Terrain India- Constraints in Reconstruction of Precambrian Assembly of Gondwanaland. Proceedings of ninth international Gondwana symposium, 2, 1003-1028.

Harinarayana, T., Naganjaneyulu, K., Manoj, C., Patro, B.P.K., Kareemunnisa Begum, S. Murthy., Madhusudana Rao., Kumaraswamy., V.T.C. and Virupakshi, G., 2003. Magnetotelluric investigations along Kuppam–Palani geotransect, South India-2D modeling results. Jour. Geol. Soc. India. Geol. Soc. India, Memoir (in press).

Harris, N.B.W., Santosh, M., and Taylor, P.N., 1994. Crustal evolution of South India: constraints from Nd isotopes, Jour. Geology, 102, 139-150

Ramakrishan, M., 1993. Tectonic evolution of the granulite Terrains of Southern India. Geol. Soc. India. Memoir 25, 35-44.

Reddy, P.R., Rajendraprasad, B., Vijaya Rao, V., Kalachand Sain, Prasada Rao., Prakash Khare., and Reddy, M.S., 2003. Deep seismic reflection and refraction/ wide angle reflection studies along Kuppam-Palani transect, South India. Geol. Soc. India, Memoir (in press).

Singh, A.P., Mishra, D.C., Vijay Kumar, V. and Rao, M.B.S.V., 2003. Gravity Magnetic signature and crustal architecture along Kuppam-Palani geotransect, South India. Geol. Soc. India, Memoir (in press).