PROCEEDINGS OF A DISCUSSION MEETING ON CONTINUING CRUSTAL DEFORMATION IN SOUTHERN PENINSULAR INDIA

[Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, Sept.18-19, 1995]

Objectives

Recognizing the geomorphic, tectonic and geophysical changes taking place in southern Peninsular India and cognisant of the signals emanating from its overstressed crust,a discussion meeting was organised during September 18-19, 1995 at the Jakkur Campus of the JNCASR. The objective was to stimulate individual, collective and frontline institutional research capacity to define and address the problems of estimating the potential of natural hazards in southern Peninsular India.

Discussions took place under the following five themes - deformational behaviour of the Peninsular India, tectonics of magmatic bodies and metamorphism, geomorphological and sedimentological aspects of neotectonic movements, conditions of gravity, heat-flow, rheology and seismicity, and identification of hazard zones and measurements of strain and movements. An in-depth analysis was then carried out in the light of these discussions for identification of most hazard-prone areas in the southern peninsula. The areas subject to continuing crustal movements and attendent natural hazards such as earthquakes, landslides, drastic modification of groundwater regime and coastal erosion were thus selected for comprehensive studies.

Delineation of Zone of Crucial Import

A nearly 400 km wide transect embracing the Palghat-Kaveri belt, the Biligirirangan-Sandur Ridge, the Moyar-Bhavani-Attur Shear Zones, and the Eastern Ghat-Coromandel Coast belt was *a priori* identified as a zone of manifest crustal instability and therefore of crucial import to social well-being, where a few selected multidisciplinary investigations need to be carried out to illuminate the geodynamic perspective of the area. The east-west zone would encompass the region between the 13° latitude (Mangalore-Madras line) in the north and 10°30' parallel (Fig.1). This zone delineates that part of the south Indian shield which since the Archaean has suffered a succession of morphogenic, tectonic, magmatic, hydrothermal and seismic events progressively creating the mechanical defects (faults and shear zones), whose response to present-day plate convergent stresses produce the geodynamic happenings which we are witnessing today. These critical belts need to be investigated incisively for creating an understanding of the ongoing processes through their signals that are perceptible in the changing landforms and related geological and geophysical features.

The following minimal set of scientific investigations have been accordingly identified to shed significant light on the processes that control the evolution of the regimes of natural hazards so that knowledge-based effective mitigation strategies can be designed.

Framework of Geological and Geophysical Conditions

The southern Indian Peninsula is an accreted terrain amalgamated at various stages from several microplates around a continental nucleus from 2.5 billion through 2.1, 1.7 and

0.5 billion years. These tectonic boundaries represent first-order planes of weakness which have been repeatedly reactivated even as late as in the Quaternary period. This is eloquently

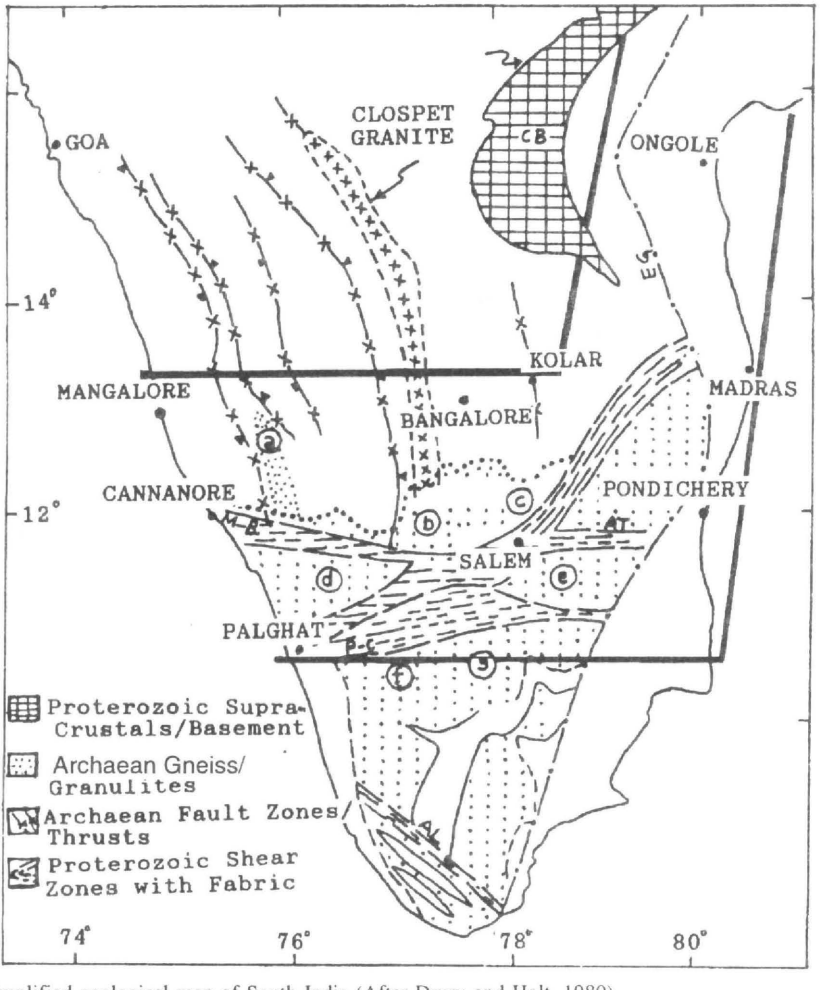

Fig.1. Simplified geological map of South India (After Drury and Holt, 1980)
a = Coorg, b = BR Hill, c = Shevroy, d = Nilgiri, e = Kollimalai, f = Anaimalai, g = Palani, AT = Attur Shear, M-B = Moyar-Bhawani Shear Zones, P-C = Palghat Kaveri Lineament, AL = Achankovil Lineament, EG= Eastern Ghat Zone.

borne out by the youthfulness of the terrain in the deformed zones, (B.P. Radhakrishna, R. Srinivasan). Sharp variations in crustal structure represented by its ancient fabric, topographic loading and the lithospheric rheology of its different blocks together determine its current dynamism; and all these in turn need to be modelled in sufficient detail for understanding their integrated tectonic response to currently active stress (T.M. Mahadevan).

The relatively stable cratonic nucleus is encircled partially (in the south and east) by mobile belts characterized by a multiplicity of active shear zones, thrusts, faults and fractures as revealed by seismicity. These still active faults and fractures trending NNW-SSE, ENE/ESE - WSW-WNW and NE-SW are, however, quite ancient (of the Precambrian

origin) and have provided the mechanical pathways for the passage of hydrothermal solutions and emplacement of magmatic bodies (S.V. Srikantia, A.S. Janardhan, M. Jayananda, T.R.K. Chetty and S.A. Khan).

Geomophological investigations show that the terrains of the Nilgiri-Kodaikanal massif, Western Ghat and the Moyar-Bhavani Shear Zones as well as the coastal belts of Bharatapura and Kerala have been affected by Recent and continuing tectonic movements (B.P. Radhakrishna and R. Vaidyanadhan). The east-west Mulki-Pulicat belt seems to have buckled up in the Quaternary period, thus deflecting and recarving the drainage system of the Karnataka craton (K.R. Subramanya).

Seismic tomography indicates existence of a low velocity layer beneath the mobile belts of granulites and the Eastern Ghat (S.S. Rai). The latter and the Kaveri-Palghat belt are zones of considerable tectonic disturbance and repeated magmatic activity. This zone is therefore a significant candidate for the measurements of strains and tectonic movements and strain rates, through GPS and geodetic levelling (V.K. Gaur). This is the zone where mapping of the loci of earthquakes, measurements of helium and radon emissions (R.U.M. Rao) and analysis of fluctuation of groundwater level and circulation, and of variation in spring discharges need to be done (A. Subramanian).

There is also a sharp change in crustal thickness along the Palghat-Kaveri belt - 35 km in the north compared to 44 km in the south as indicated by shape of gravity gradient and magnetic anomalies. Significantly the NNW-SSE and NE-SW trending gravity anomaly belts intersect each other near Tirupattur south of Bangalore, which is likely to be an area of tectonic disturbances (D.C. Mishra).

The mobile belts are characterized by fault - and fracture-deformation and rapid strain accumulation of the order of 10^{-7} to 10^{-8} /yr of thermal influx of fluids and density variations. Episodic reactivation of the fault zones in the mobile belt make them serve as slip planes, while the unloading due to erosion and consequent topographic reduction results in decompression, calling forth buoyancy forces that generate instability (U. Raval).

The coastal belts adjacent to the mobile belts are equally active in both the Eastern Ghat and the Western Ghat, where sediments of distinctive composition and character are accumulating in a manner peculiar to the basins delimited by active strike-slip faults trending oblique to the coast line (G.V. Rajamanickam).

Course of Action

Dr. B.P. Radhakrishna agreed to provide the overall guidance for these studies and Prof. V.K. Gaur, Prof. R. Vaidyanadhan and Prof. K.S. Valdiya would coordinate the endeavours of geophysical, geomorphological and geological investigations:

Finer-scale delineation, characterization and evaluation of the recent behaviour of structures within the identified transect with special emphasis on the occurrence of shear zones, faults, fractures and the determination of deformation fields, on the basis of rock fabric (D.P. Rao, R. Srinivasan, T.R.K. Chetty, M. Jayananda and S.A. Khan).

Pressure - temperature - fluid flux history of rocks in the zones of deformation - in both ancient and reactivated shear belts (A.S. Janardhan, C. Srikantappa, B. Mahabaleswar, G.R. Ravindra Kumar, T. Radhakrishna and C. Leelanandam).

Landform modifications and evolutions of new geomophic features; rate of erosion and sedimentation; Water divides, palaeodrainage and drainage deflections; changes in groundwater circulation and spring discharges in shear-zone terrains, submergence and elevation of coastal belts, with the objective of reconstructing thermodynamic history of the uplift and subsidence; Fission-track dating of the critical rocks (R. Vaidyanadhan, K.S. Valdiya, K.R. Subramanya, A. Subramanian, V.C. Chavadi, B.G. Wagle and H.S. Saini).

Patterns and rates of sedimentation in the coastal and offshore belts and in favourably located basins, with special reference to palaeoseismic structures and deposition, influx of heavy minerals; clays, rock clasts, etc; and search for the provenance, radiocaron dating of organic remains (G.V. Rajmanickam, N.H. Hashimi, A.R. Gujar, V. Purnachandra Rao, Thrivikramji and G. Rajagopalan).

Definition of the crust-mantle structure beneath identified transect on the basis of geoid, gravity and magnetic conditions, seismicity, rheological state, heatflow, emanations of helium and radon gases; and magneto-telluric studies (D.C. Mishra, U. Raval, S.S. Rai, R.U.M. Rao, A.P., K. Rajendran and S.V.S. Sharma).

Current budget of strains and geodetic movements; modelling of tectonic boundaries in an attempt to predict the most sensitive areas (V.K. Gaur and R.N. Singh).

Hazard-zone mapping on the basis of distribution of epicentres, occurrence of landslides (past and present), location of palaeoseismic sites, geomorphic changes, drainage reversals, measurement of movements and strain accumulation (V.K. Gaur, S.V. Srikantia, V.N. Vasudev, C.V. Ramakrishna Rao, N. Chandrashekhar, T.M. Mahadevan, K.S. Valdiya and D.P. Rao).

Jawaharlal Nehru Centre for
Advanced Scientific Research
Jakkur P.O.
Bangalore - 560 064.

K.S. VALDIYA

AEROGEOPHYSICAL MAPS OF INDIA

The Airborne Mineral Surveys and Exploration (AMSE) Wing of the Geological Survey of India has brought out in May 1995, a "Catalogue of Aerogeophysical Maps" listing details of 2486 aerogeophysical maps produced so far under various programmes as under:

Operation Hard Rock (OHR); US-collaboration: multisensor maps covering 97,395 sq.km., in parts of Rajasthan, Bihar, West Bengal and Andhra Pradesh.	520
BRGM-CGG; French collaboration: multisensor maps covering 76,460 sq.km., in parts of Rajasthan, Gujarat, Madhya Pradesh and Karnataka.	625
NGRI collaboration; Aeromagnetic Maps of the Narmada-Son Lineament and Cuddapah Basin covering 1,42,982 sq.km.	226
National programme of Aeromagnetic Survey in collaboration with NRSA covering so far an area of 11,96,058 sq.km., in parts of Kerala, Tamil Nadu, Bihar, Madhya Pradesh, Maharashtra and Goa.	928
Exclusively AMSE carried out multisensor surveys covering an area of 73,670 sq.km., in parts of Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, North Eastern Region, West Bengal, Uttar Pradesh and Bihar.	187
Total	2486

With the implementation of the recent liberalised mineral policy of the Government of India, there has been a growing demand from foreign as well as domestic investors, for these aerogeophysical maps, for mineral exploration and other purposes.