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REMOTE SENSING REVEALED MORPHOTECHTONIC ANOMALIES AS A TOOL TO NEOTECTONIC MAPPING - EXPERIENCE FROM SOUTH INDIA

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ABSTRACT

The southern part of the Indian Peninsula which is thought to be inert to younger earth movements by the geoscientists has revealed distinct morophotectonic anomalies indicating the possibilities for recent earth movements. The Satellite captured remotely sensed images provide unique and advanced possibilities in understanding the various morophotectonic features. This has been possible because of the synoptivity, multispectral photocaptivity and the repetitivity of the orbital satellites. Taking advantage of this technology, the raw & digitally processed IRS 1A satellite data were interpreted for parts of Westernghats of Tamil Nadu, South India covering Anamalai - Palani hill ranges in the north and Varshanad hill ranges in the south with the intervening Kambam valley in the centre. These IRS 1A images were interpreted for preparing maps showing Neotectonic domains and corridors.

All the lineaments were interpreted which all fall in general N- S, NE-SW, NW-SE and E-W directions. From these lineaments, the zones of unifrequency and radial lineaments, iso fracture maxmima zones, lineaments density maxima zones and lineaments intersection intensity maxima zones were buffered out as possible Neotectonic corridors.

Similarly various tectano geomorphic anomalies such as shapes of the crestlines and the strike escarpments, the distribution of the dissected and undissected plateaux, active dip steep slopes and active obsquent slopes were mapped using IRS 1A satellite data. These tectano geomorphic anomalies when analysed in relation with lineament fabric of the area provided interesting information on the Neo active tectonic scenario of the region. The amalgamation of these anomalies show that the ENE - WSW trending faults and the N-S trending faults are tectonically active in the area.

1.0 INTRODUCTION:

The geoscientists of the Indian Peninsula were all along been thinking that the southern part of the Indian Peninsula is stable and inert to younger earth movements. Later studies during the past 3- 4 decades have shown indications for possible recent earth movements. Earlier studies in this line in the Indian subcontinent was mostly restricted to the Himalayas, Son - Narmada lineament zone and also Andamans (Oldham 1901, West 1962, Ghosh 1976, Sharma 1978, Ravishankar 1987, Amalkar 1988, Bakliwal & Ramasamy 1989, Rakshit and Prabhakara Rao 1989, Bhave et.al 1989 and many others).

The studies carried out in the southern part of the Indian Peninsula have also brought out evidences for the Quaternary earth movements. (Vaidyanathan 1967, Vemban et.al 1977, Ramasamy et.al 1987, Ramakrishnan 1988, Ramasamy 1989, Narashiman 1990, and many others).

Further studies (Ramasamy, 1995, Ramasamy & Balaji 1995, Ramasamy & Karthikeyan 1998), have brought out certain set of new techniques in neotectonic mapping using satellite derived terrain anomalies and hydrological anomalies.

In this direction the present study is a newer attempt to prepare a neotectonic map exclusively from the lineaments and tectano geomorphic anomalies deduced from the satellite remote sensing data. For this documentary study 9400 sq.km area falling in Anamalai-Palani hill ranges in the North, Kambam valley in the centre and the Varushanad hill in the south (Fig - 1) has been selected.

2.0. METHODOLOGY

In the study area, a detailed lineament map was prepared by interpreting both raw and the digitally processed IRS 1A satellite data. From these lineaments, the zones with unifrequency and radial lineaments were demarcated. Further various lineament derivative maps such as isofracture, lineament density and lineament intersection intensity were prepared and the maxima zones were buffered out. In addition, detailed tectano geomorphic map depicting the shapes and the distribution of crestlines and escarpments, dissected and undissected plateaux and active slopes was prepared. By integrating all the above lineament and tectano geomorphic anomalies, the zones of possible neotectonic /active tectonic corridors / lineaments were identified.

2.1 Lineament Anomalies And Neotectonics:

A precise lineament map was prepared from the raw and the digitally processed IRS 1A/1B data on the basis of tonal, textural, relief, vegetational, soil tonal and drainage linearities and curvilinearities (Fig. 2). From this lineament map, the anomalous pattern in lineaments, zones of high lineament frequencies and high densities zones were demarcated as neotectonic zones.

2.1.1 Lineament Pattern:

The lineament map was studied in detail and the zones of unifrequency lineaments (zones of parallel and subparallel fracture swarms)were identified. This was found in six locations (1-6, Fig.3). The radial lineaments were found in six locations (I - VI, Fig.3).

2.1.2 Isofracture:

Total number of lineaments per 1 sq.km were counted plotted in the respective grid centres and contoured and the lineament maxima axes were drawn along the crest of the elliptical contours of maximum values. Such isofrature maxima axes, ingeneral were found in E-W and N-S directions.

2.1.3 Lineament Density:

Similarly, the total length of lineaments in 1sq.km area were measured plotted in the respective grid centres and thus the lineament density diagram was generated . From such lineament density diagram, density maxima axes were drawn along the crest of ellipitical contours of maximum values and such density maxima axes were found in four azimutual frequencies such as N-S, NE-SW, E-W and NW-SE.

2.1.4 Lineament Intersection Intensity:

In addition, the total number of lineament intersections were counted per 1 sq.km area and contoured and the lineament intersection intensity maxima axes were drawn which have again fallen predominately in N-S and E-W directions.

2.1.5 Discussions:

The unifrequency lineaments, radial lineaments and the maxima zones of isofracture, lineament density and lineament intersection intensity were transferred on to a common overlay (Fig.3). Such an integration has shown that these different lineament anomalies such as unifrequency, radial lineaments, isofracture maxima, lineament density maxima and the lineament intersection intensity maxima have coincided in different parts of the area in various permutations and combinations. However, wherever more than three such anomalies have coincided only those were taken as probable zones of neotectonism (A -G, Fig.3). These have generally fallen in N-S, E-W and NE-SW orientations except domain 'F' which has fallen in NW-SE direction.

The N-S trending tectonic weak zones (zones A, C and E in Fig. 3) have coincided with N-S faults / lineaments which have been documented to be Pleistocene extensional fractures (Ramasamy and Balaji 1995, Paul 1996, Ramasamy et.al 1998), where as the E - W trending tectonic weak zone 'D' (Fig 3) has fallen in close proximity of the crestline fractures observed along the E-W trending cymatogenic arch (Ramasamy et.al 1987, and Kumanan & Ramasamy 2001). Similarly the E-W trending tectonic weak zone 'B' (Fig. 3) has again fallen in close proximity to

E-W trending Palghat tectonic gap of Subramanian and Muralidharan (1985), which was subsequently doubted for the ongoing tectonic subsidence (Ramasamy and Balaji 1995). The NE-SW trending weak zone 'G' (Fig. 3) has fallen parallel to the NE-SW trending Kambam tectonic valley which was demonstrated to be of Pleistocene - Holocene tectonic graben (Ramasamy & Balaji 1995, and Ramasamy & Karthikayan 1998). Hence all the seven such weak zones were mapped as neotectonic corridors.

2.2 Tectano Geomorphic Anomalies And Neotectonics:

From the geomorphic map interpreted from IRS 1A/1B data, only the tectano geomorphic features like Crestlines, Plateau types, Escarpments & different types of slopes were studied in conjunction with lineaments of the area and the tectonic weak zones were demarcated.

2.2.1 Pattern Of Crestline And Escarpments:

The crestline features and the pattern of escarpments were critically interpreted. These features have shown curvilinearity at some places, 'S' or sigmoidal shaped in some places, the later indicating probable sinistral drags. Such mega 'S' shaped crestlines (1 - 5, Fig. 4) and escarpments (a- e, Fig. 4) were observed in five places each. When these features were studied in relation to the lineaments, the same have indicated that such sigmoidal crestlines and escarpments have mostly confined within the NE -SW trending fault systems which might have moved sinistrally and caused these sigmoidal crestline and escarpments.

2.2.2 Plateau Types And Distribution:

The pattern and the spatial distribution of the plateau has shown that the eastern half of the Kodai hill is mostly an undissected plateau, where as the western half are mostly dissected (Fig. 5). Strikingly such undissected and dissected plateau regions were separated by a spectrum of N-S trending lineaments.

2.2.3 Slope Pattern And Neotectonics:

From the topographic sheets and satellite imagery the slope classification was made for the eastern half of the Kodai hills. The slopes have been classified as active and passive slopes respectively on the basis of absence and presence of vegetation. Such slopes were further divided into dip and obsequent slopes and then subdivided into steep, moderate and shallow slopes.

2.2.4. Discussion:

The 'S' shaped sinistral drags in crestlines and escarpments with the NE-SW trending faults indicate on going tectonic movements along these faults. In a wet clay deformation model (Cloos in Badgly, 1965), observed development of sigmoidal fractures in the blocks entrapped in between two sinistral faults when they were subjected to compressive force with little obliqueness to the preexisting sinistral faults. The Pleistocene tectonic model for Tamil Nadu (Ramasamy and Balaji 1995), has described that most of the NE-SW trending lineaments are Pleistocene sinistral faults. They have further documented sinistral strike slip movements along the Mio-Pliocene Sandstone in Cuddalore - Pondicherry area along two major NE-SW trending faults between Pondicherry in the Northeast and Kambam valley in the Southwest. In addition, these NE-SW faults show clear strike slip sinistral movements in their southern extension along the west coast and also shifted the coral islands of Lakshadweep and Maladives (Ramasamy, 1995). Hence, all such NE-SW trending lineaments of the study area can be marked as Neotectonic corridors (Fig. 4) with probable sinistral movements.

Occurrence of dissected plateau in the west and undissected plateau in east of the N-S lineaments suggest that the eastern part of the Kodai hills must be static and the westernpart of the Kodai hill might have undergone block upliftment along these N- S trending lineaments. (Ramasamy et.al, 1995) A number of N- S trending faults have been observed along the east coast of Tamil Nadu, and these faults have faulted, uplifted and down faulted the Mio-Pliocene sandstone in Pattukottai - Mannargudi area, thus indicating post Mio-Pliocene age for these N-S lineaments has also been observed an acute turning of river Cauvery towards southerly along these N-S lineaments (Paul, 1996) and the age dating of the Paleochannels suggesting 2300 years B.P for this southerly turn of Cauvery river. Hence, these N-S lineaments of the study area also must be significant neotectonic / active tectonic corridors.

In slope map, the active-dip-steep slope categories (ADS1 + ADS2 in Fig 6) in general have two orientations, one in N-S and the other in NE-SW to ENE-WSW direction. Similarly the active - obsequent - steep slope features (AOS1 and AOS2 in Fig. 6) were found in E-W to ENE-WSW directions coinciding with the nearly E-W trending very active quaternary Palghat graben (Subramanian and Muraleedharan, 1985). Hence, the N-S and NE-SW and E-W trending lineaments in the study area have also been marked as active neotectonic corridors.

CONCLUSIONS:

The analysis of lineament anomalies, crestlines and escarpments, the pattern and spatial distribution of various plateau types and the spatial distribution of various slopes have indicated that all the N-S, NE-SW, and E-W trending lineaments are tectonically active in the area. This study has further indicated that such type of remote sensing derived morphotectonic analysis can give potential information on such neotectonic mapping.

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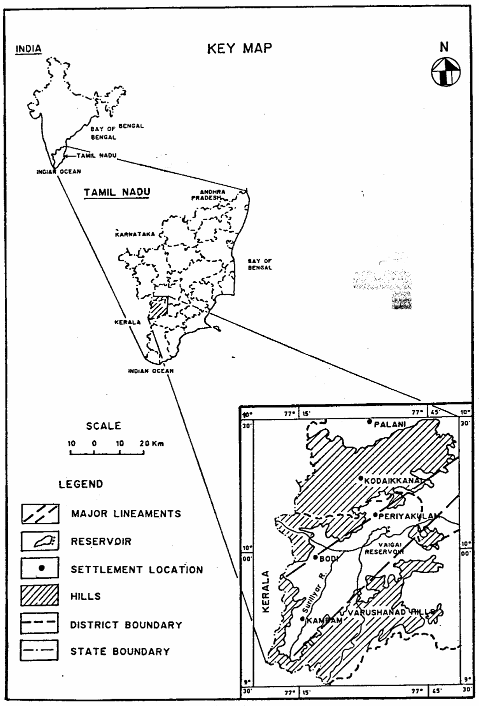

Fig . 1

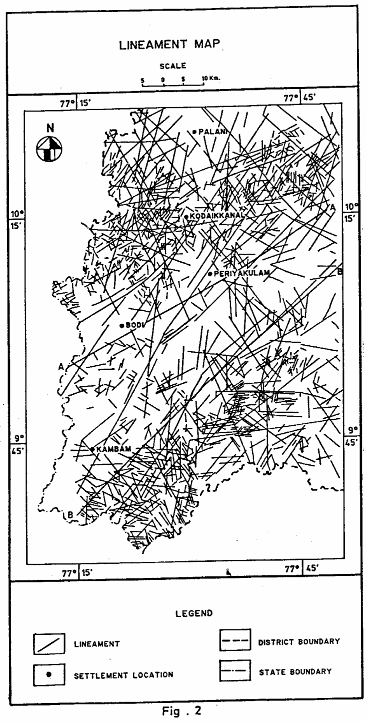

Fig . 2

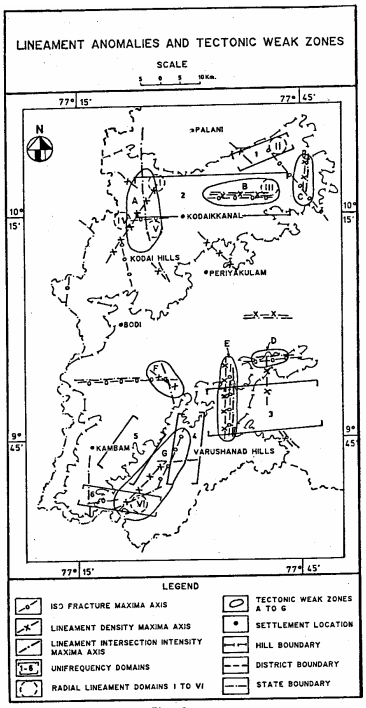

Fig . 3

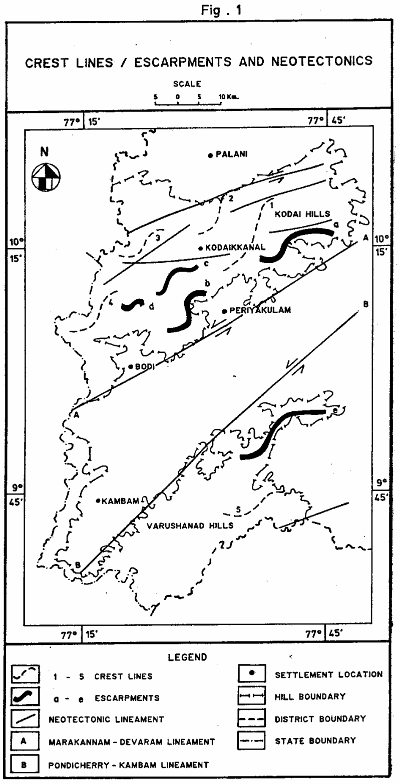

Fig . 4

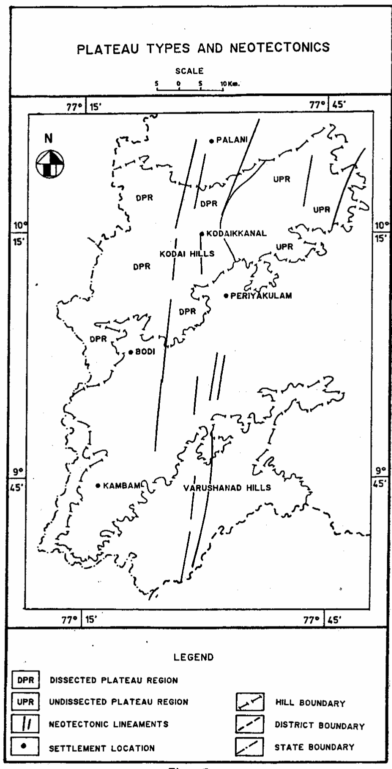

Fig . 5

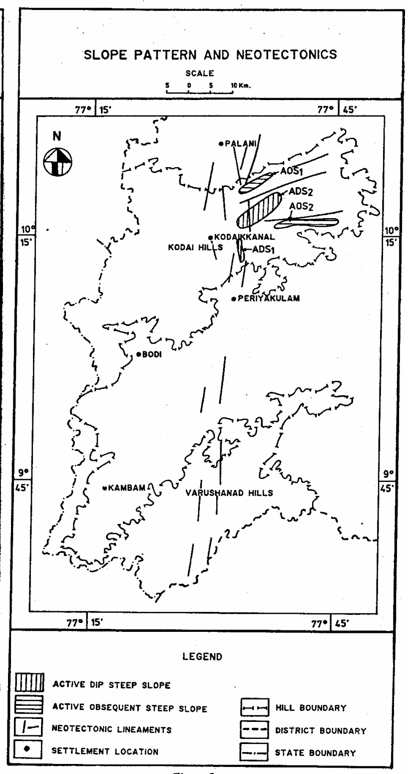

Fig . 6