CHAPTER - VIII

VALIDATION OF NEO-ACTIVE TECTONIC MODEL
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8.1 GENERAL

Under the present scenario of fast recurring seismicities and disastrous earthquakes around the world, the present research study was taken up primarily to evolve concepts and methods for Neo–Active tectonic mapping using all possible geologic, geomorphic, geophysical and geohydrological anomalies, so that highly precisioned Neo–Active tectonic zonation mapping can be done to provide a firm baseline data for earthquake mitigation. The various anomalies studied have not only corroborated with each other leading to the development of a new methodology but also lead to the detection of a unique Neo–Active tectonic model for the study area with E–W trending land arching, N–S block faulting, NE–SW sinistral and NW–SE dextral strike slip faulting and E–W release fracturing. Hence, at the next stage, such Neo–Active tectonic model deduced from the study was validated, as then only the present methodology can be confirmed and propagated for operationalisation. Hence, such validation was attempted using vital tools like gravity and historical seismicity data.

8.2 GRAVITY DATA

8.2.1 Study Area

The gravity data published by Geological Survey of India (Anon 2000) was subjected to DEM modeling using “3D Analyst Module” of ArcGIS software, which gave 3D view of the gravity data. From such 3D visualized gravity data, the axes of gravity highs and lows were interpreted respectively from the gravity ellipsoids / ridges and linear gravity depressions (Fig.8.1). For precise interpretation, the 3D visualized gravity was rotated in multiple angles (Fig.8.1B, 8.1C) using the provision available in the 3D Analyst Module. These gravity highs and lows so interpreted were analysed for the study area (P,Fig.8.1). The same has indicated that the major near E–W gravity high (1) has coincided with the axis (2) of the E–W trending Vaniyambadi–Chennai cymatogenic arch brought out in the Neo–Active tectonic model in the present study (Fig.8.1).
Fig. 8.1 - 3D GIS image showing gravity anomalies and Neo-Active Tectonics
coincidence of gravity high with the axis of the cymatogenic arch convincingly confirms such arching and the related crustal thickening.

8.2.2 Regional Picture

However, in order to have more confirmation, such gravity highs and lows were interpreted for entire South India from the GIS based 3D visualized gravity data. The same has revealed alternately arranged E–W gravity highs (3) and lows (4), N–S aligned highs (5) and lows (6) and NE–SW oriented highs (7) and lows (8, Fig.8.1). These regional N–S and NE–SW gravity anomalies matched respectively with Holocene block faults and sinistral faults brought out in the present Neo–Active tectonic model for the study area and their extension in the adjacent region as well. Hence by and large, the gravity anomalies provided an excellent confirmation to the Neo–Active tectonic model brought out in the study that

- The E–W land arching of Vaniyambadi–Chennai region (2, Fig.8.1) is confirmed by gravity high (1, Fig.8.1) suggesting crustal thickening,
- The E–W trending gravity highs (3) and lows (4, Fig.8.1) coincide with alternate E–W cymatogenic (Pleistocene–Holocene) arches and deeps observed in South India by Ramasamy and Balaji (1995). This also corroborates with E–W trending crenulations in groundwater systems (Fig.6.1–6.6),
- N–S trending gravity highs and lows (5,6, Fig.8.1) match with Pleistocene – Holocene block faults brought out in the model.
- NE–SW gravity highs and lows (7,8, Fig.8.1) coincide with regional Pleistocene sinistral faults, etc.

Though the gravity data can still be studied deservingly, the present analysis indicates clear confirmation of the Neo–Active tectonic model evolved in the present research for the study area.

8.3 HISTORICAL SEISMICITY DATA

8.3.1 Validation through Epicentres

8.3.1.1 Study Area

The historical seismicity data is again one of the best tools for validating such Neo–Active tectonic models. Hence, such historical seismicity data published by Geological Survey of India (Anon 2000) was scanned and over 250 epicenters of more
than 2.5 magnitudes were culled out and a GIS data base was generated for entire South India (Fig.8.2A).

The browsing of their distribution showed the clustering of maximum epicentres in between Mangalore in the west coast and Chennai in the east coast, considerably falling in the present study area (P, Fig.8.2A). From this, it can be concluded that the E–W land arching (cymatogenic arching) brought out in the present study area in between Vaniyambadi and Chennai is confirmed by the historical seismicity data. In addition, there was an appreciable coincidence between such clusters of earthquake epicentres and the Neo–Active tectonic zone deduced in the western part of the study area (1, Fig.8.2B) and also along the crestline fractures / release fractures (2, Fig.8.2B) of the E–W trending cymatogenic arch. Further, moderate to high magnitude earthquakes were also seen coinciding with NE–SW sinistral faults and NW–SE dextral faults (3,4, Fig.8.2B).

8.3.1.2 Regional Picture

The earthquake epicentres of the area falling south of the study area showed a dominant NE–SW and WNW–ESE to NW–SE alignments confirming respectively active sinistral and dextral faults.

8.3.2 Validation through Isoseismal Pattern

8.3.2.1 Study Area

However, in order to have still finer correlation and confirmation, isoseismal lines were drawn by feeding the above epicentres data into the “Spatial Analyst Module” of ArcGIS for entire South India (Fig.8.3). From such isoseismal lines, isoseismal maxima axes were drawn along the crest of maximum values. Again using “3D Analyst Module” of ArcGIS, 3D visualized GIS image was generated on the isoseismal pattern and similar isoseismal maxima axes were drawn along the elliptical isoseismal ridges (Fig.8.4).

The isoseismal maxima axes drawn along the crest of maximum values (Fig.8.3) and the maxima axes so drawn from the 3D visualized isoseismal data (Fig.8.4) were integrated and a final map showing all the isoseismal maxima axes was prepared (Fig.8.5A). The same has shown the general N–S, NNW–SSE, NNE–SSW and E–W / ENE–WSW oriented isoseismal maxima in between Mangalore in the west and Chennai
Fig. 8.2A - Distribution of epicentres in South India

Fig. 8.2B - Historical seismicity versus Neo-Active tectonic model of the study area
Fig. 8.3 - Isoseismal Lines
Fig. 8.4 - 3D GIS image of isoseismal values
Fig. 8.5A - Isoseismal maxima axes of South India

Fig. 8.5B - Seismic anomalies and Neo - Active tectonic model of the study area
in the east. Though, in the area falling in between Bangalore and Mangalore, these isoseismal maximas were aligned with dominant N–S element, as far as the study area is concerned (the area between Bangalore and Chennai) such isoseismal maximas have strictly coincided with the E–W trending axial portion of the cymatogenic arch or the zone of upliftment established in the present study (1, Fig.8.5A).

Again in order to validate the other Neo–Active tectonic faults / lineaments brought out in the study area, the vector GIS layers having isoseismal maxima axes and the various grains of Neo–Active tectonics of Chennai area (viz: the E–W trending cymatogenic arch, N–S trending Holocene block faults, NE–SW and NW–SE trending respective Holocene sinistral and dextral faults and the E–W trending fractures swarms) were integrated, enlarged in the computer and studied (Fig.8.5B). The study of such enlarged formats of the same has shown that

- The E–W trending isoseismal maximas (1, Fig.8.5B) have coincided with E–W cymatogenic arch
- The N–S and NNE–SSW isoseismal maxima axes fell in azimuthal conformity with N–S active block faults (2, Fig.8.5B).
- The NE–SW isoseismal maximas have coincided with active sinistral strike slip faults (3, Fig.8.5B)
- The NW–SE isoseismal maxima axes have strictly coincided with NW–SE trending Pleistocene–Holocene (or active) dextral faults (4, Fig.8.5B) in the western part of the study area where the active tectonic weak zones again were predominantly seen in NW–SE direction.
- Again the E–W isoseismal maxima axes of the cymatogenic arch zone have also coincided with E–W trending fracture zone.

Thus, the Neo–Active tectonic model brought out during the research study was well confirmed by such historical seismicity data.

8.3.2.2 Regional Picture

In addition, the Isoseismal maxima axes were specifically analysed for the area falling south of the study area.

The same has revealed that whatever isoseismal maxima axes were seen, these were found in N–S (5), predominantly NE–SW (6) and rarely NW–SE (7, Fig.8.5A).
Amongst these, the N–S to NNE–SSW oriented isoseismal maxima axes were found to fall in parallelism and proximity to N–S / NNE–SSW trending regional Pleistocene faults inferred by Ramasamy and Balaji (1995). Whereas the more frequently found NE–SW oriented isoseismal maximas fell in proximity and parallelism to the NE–SW Pleistocene sinistral faults of Ramasamy and Balaji (1995), active faults observed by Jacob and Narayanaswami (1954), Nair (1987), Nair and Subramanian (1989) and Ramasamy (1995c).

Thus, the gravity data and the historical seismicity data have shown excellent validation of the Neo–Active tectonic model evolved in the present study and the various elements of it namely the zone of upwarping, active faults of N–S, NE–SW and NW–SE azimuthal frequencies.

8.4 SYNTHESIS

Thus, the validation studies carried out for the Neo–Active tectonic model utilizing gravity data and the historical seismicity data showed good confirmation of the model. Hence, the present newer methodology attempted involving the lineament, fluvial and coastal geomorphic anomalies, geophysical resistivity and groundwater anomalies can be used well for precise Neo–Active tectonic mapping.