UNIQUENESS OF ArcGIS 3D ANALYST MODULE IN EXPLORING, ANALYZING AND INTERPRETING THE BASEMENT STRUCTURES IN CAUVERY DELTAIC REGION, TAMIL NADU, INDIA

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INTRODUCTION

The understandings of the shallow subsurface and deep seated structures, basement configuration, sedimentation, etc. are important in Palaeo tectonics, Neotectonics, mineral exploration, oil exploration, groundwater exploration and seismic zonation. Geologists have used the geophysical datasets like gravity, seismic, magnetic and resistivity to explore, analyze and visualize the earth crust.

For example, tectonic activities during the Upper Pliocene–Lower Pleistocene were inferred by Cantini et al (2001) in Lower Arno valley, Italy, on the basis of gravity anomalies and their correlation with borehole data. Nakada et al (2002) have used gravity anomalies to bring out the zones of aseismic crustal uplifting during the Late Pleistocene period on the basis of the negative anomalies in the eastern part of Kyushu, Japan. Two dimensional electrical resistivity tomography was used by Caputo et al (2003) to detect and map the Late Quaternary tectonic activities in Tyrnavos Basin, Greece. Similarly, Rizzo et al (2004) have used electrical resistivity Tomographic method to identify Quaternary faults in parts of Apennine chain, southern Italy. Again, the shallow geophysics was used in conjunction with palaeoseismology and structural analysis, to identify and map the zones of Neotectonism in Western Border Fault (WBF) in Upper Rhine Graben, Germany by Peters et al (2005). In Indian subcontinent many geoscientists have used geophysical data to explore the earth crust structures and deformations, for example, Reddy and Ramakrishna (1981) have identified the geophysical anomalies related to recent tectonic movements in parts of Great Indian Desert. Qureshy (1964), on the basis of various geophysical anomalies, brought out a number of peripheral faults in parts of Tamil Nadu and inferred that the northern Nilgiri massif and the southern Anamalai–Palani hill region of the Western Ghats were uplifted with in between subsidence along Palghat during the Quaternary period. Qureshy (1982) has utilized the regional gravity and magnetic map of India to bring out the tectonic framework of the Indian subcontinent. In addition, such tectonic framework interpreted was also well correlating with surfacial lineaments deciphered from Landsat data. Further, from the gravity and magnetic anomalies, he deciphered the zones of tectonic rejuvenation. Balaji and Ramasamy (2005) have developed a technique of creating GIS images using multiple depths isoresistivity data and therefrom they brought out the pattern of folding and faulting upto 100m depth.
Further, the analysis of geophysical datasets in two dimensional is tedious and difficult to decipher subsurface geological structures. The recent advancement and developments in the Geomatics technology comprising of Remote Sensing, GIS, Digital Photogrammetry, GPS, etc. have enormous potential in mapping and modeling the earth surface and subsurface geological process / system. In the various geomatics tools, the 3D Analyst module of ArcGIS has got advanced virtues and avenue in Visualizing and analyzing the shallow subsurface and deep seated geological structures.

The present paper discusses the uniqueness of 3D Analyst Module of ArcGIS in understanding the earth basement configuration in Cauvery deltaic region, Tamil Nadu.

**VISUALIZATION OF SHALLOW SUBSURFACE STRUCTURES USING 3D ANALYST**

**3D Visualization of Multi Depth Resistivity Data**

By keeping the geophysical resistivity locations of the 200 points as X and Y and their corresponding apparent resistivity values of at 25m, 50m, 75m and 100m depth respectively as Z1, Z2, Z3 and Z4, using the ‘3D Analyst Module’ of Arc GIS independent and multi-depth Digital Resistivity DEM Models were generated for 25m, 50m, 75m and 100m depths (Fig.1). Such resistivity DEMs of multiple depths were interpreted specially for locating the zones of circular and elliptical resistivity highs and lows which are nothing but the resistivity domes (resistivity maximas) and resistivity basins (resistivity minima). Similarly, by duly interpreting the resistivity DEMs, the anomalous and abrupt resistivity breaks were interpreted along the slopes and the same were called as resistivity lineaments. Thus, the interpretation of the DEMs has revealed the resistivity domes, basins and resistivity lineaments in a number of places and at different depths (Fig.1).
Fig. 1  3D Visualization of Shallow Geological Structures using Geophysical Resistivity data – Cauvery Sector

3D Visualization of Depth to (or) Top of Resistivity Layers

(A) Generation of Resistivity Layers

After the visualization of resistivity domes, basins and resistivity lineaments / faults from the multi depth resistivity DEMs, a study was taken to analyze the shallow subsurface on the basis of resistivity by fractionating them into different layers using IPI2WIN resistivity sounding interpretation software, different resistivity layers were brought out and 3D resistivity layers pictorial output prepared using 3D Analyst Module of ArcGIS is shown in Fig.2
Finally, shallow subsurface resistivity domes, basins and lineaments / faults visualized were integrated and holistic picture on shallow subsurface architecture of Cauvery deltaic region was brought and the same shown in Fig.3.
Fig. 3 Shallow subsurface structures revealed from geophysical resistivity data using 3D Analyst Module of ArcGIS

The same revealed that the

- Shallow subsurface resistivity domes were aligned in NE-SW and NW-SE directions. Along the Karaikal – Mayuram - Llaiyur region, the resistivity domes were aligned in NW-SE direction and the same aligned in NE-SW directions along the Ammapettai – Tiruvidaimardur and Pattukottai – Kottur – south of Tiruvarur regions (Fig. 3).

- Shallow subsurface resistivity basins were also mostly aligned in NE-SW and NW-SE directions. The NE-SW resistivity basins were seen in Orattanadu – Mannargudi – Nannilam and Atirampattinam – Tirutturaippundi regions and a NW-SE resistivity basin was aligned along Tirukkadaiyur – Sirkazhi – Chidambaram region

- Shallow subsurface resistivity lineaments / faults were mostly oriented in NE-SW, NW-SE, N-S and E-W directions. The above resistivity domes and basins were bounded by the NE-SW and NW-SE lineaments (Fig. 3).

3D VISUALIZATION OF DEEP SEATED GEOLOGICAL STRUCTURES

The deep seated geological structures of Cauvery basin derived from gravity and deep seismic sounding by ONGC has been taken as such (Fig. 4).

The same revealed that the alternate arrangement of ridge or horst and basin or graben structures. They named those structures as follows from north to south such as Pondicherry subbasin (A), Kumbakonam ridge (B), Thanjavur subbasin (C) and Tranquebar subbasin (D), Mannargudi Ridge (E) and Karaikal ridge (F), Nagapattinam subbasin (G) and Vedaranniyam terrace (H, Fig. 4)
The shallow subsurface resistivity domes, basins, lineaments / faults derived from the multi depth resistivity, resistivity of the layers and depth to (or) top of resistivity layers were integrated with deep seated horst and graben (highs and lows) structures brought out by ONGC (Fig.5).
A) Pondicherry sub basin, B) Kumbakonam ridge, C) Thanjavur subbasin, D) Tranquebar sub basin, E) Mannargudi ridge, F) Karaikal ridge, G) Nagapattinam basin, H) Vedaranniyanam Terrace

- Deep seated highs, lows and faults
- Shallow subsurface highs, lows and lineaments / faults deduced from the resistivity data
- Surface domes deduced from the geomorphic and drainage anomalies
The Shallow subsurface resistivity domes and basins which were aligned in NE-SW directions are almost coinciding with the NE-SW aligned deep seated ridges and basins. For example:-

- The NE-SW Resistivity domes were seen in Ammapettai – Tiruvidaimardur and Pattukottai – Kottur – south of Tiruvarur regions are respectively matches with the deep seated Kumbakonam and Mannargudi ridges.

- Similarly, NE-SW resistivity basin found in Orattanadu – Mannargudi – Nannilam region are strictly coincides with the deep seated Thanjavur and Tranquebar subbasins and a resistivity basin of Atirampattinam – Tirutturaippundi are also partly matches with the deep seated Nagapattinam subbasin.

The Shallow subsurface lineaments / faults extracted from the geophysical resistivity data upto 100 m depth were mostly oriented in NE-SW, NW-SE, N-S and E-W directions. Further, the NE-SW resistivity lineaments / faults coinciding with the boundaries of such deep seated NE-SW trending ridges and basins.

The most of the surface circular features fell in the NW-SE aligned Karaikal – Mayuram – Llaiyr and NE-SW aligned Ammapettai – Tiruvidaimardur shallow subsurface resistivity domes.

While the deep seated lineaments / faults were oriented in NE-SW directions, the lineaments / faults extracted from the geophysical resistivity data upto 100m depth and SRTM based shaded relief images, tectono-geomorphic and drainage anomalies indicates NE-SW, NW-SE, N-S and E-W directions.

Almost all the NE-SW deep seated lineaments / faults matches with the shallow subsurface lineaments deduced from resistivity data.

CONCLUSION

The present paper shows the credential of 3D Analyst module of ArcGIS in visualizing and analyzing geophysical datasets like multi-depth resistivity, gravity, magnetic, etc. to reveal the shallow subsurface and deep seated geological structures of Cauvery deltaic region and establishing the relation between the deep seated geological structures/processes and shallow and surface geological structures/processes.
REFERENCES


