

Research Paper

# A GEOMATICS APPROACH - STRUCTURAL MAPPING AND AUTOMATED LINEAMENT EXTRACTION IN PARTS OF CENTRAL TAMIL NADU

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The area of this study is one of the important places in central part of Tamil Nadu, which contains many ore deposits, plantation fields, and villages. Because of this, study of geological structures (lineaments) is one of the most important factors, which gives indications about the locations of ore deposits, and groundwater movements. Shaded relief images and Landsat 8 are helpful in identifying lineaments in different distinct relief and topography. The method can enhance lineaments at different orientations by simulating topographic illumination under varied light directions. Combining four shaded relief images into a final image leads to enhancing lineaments within the four sun azimuth directions. Two shaded relief images with multi-directional light were created, the first image with the four azimuth angles of the light sources that are 0°, 45°, 90° and 135°, and the second image with the four azimuth angles of the light sources that are 180°, 225°, 270°, and 315°. Both images have been used for automatic lineament extraction using PCI Geomatica software. The extracted lineaments of the first image show that the most automatic lineaments represent positive lineaments; and the automatic lineaments of second image represent negative lineaments of the study area. The directional analysis of the automatically extracted lineament maps have been done with the reference of the fault map of the area. The results verify the similarity in the directional behaviour of the lineaments, the fault lines and the structures measured in the field. The main trends of the extracted lineaments of both images are NW-SE, N-S, E-W and NE-SW.

Keywords: Digital elevation model, Shaded relief, GIS, Geomatica and automatic lineament

## INTRODUCTION

DEM data are digital elevation data set demo the topographic surface form of any area. Topographic features can be mined from digital elevation data by applying special computer processes. These contain slope, aspect and

shaded relief algorithms. The most widely used is the shaded relief algorithm, because perception of elevation can be attained and when combined with other type of images, new products can be produced. DEM, unlike Landsat images, represent true reape projections with no distortion;

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tonal variations are entirely identified with relief, the sun position can be placed anywhere above the terrain surface, and in most cases, DEM has better resolution than satellite images (Batson *et al.*, 1975; Schowengerdt and Glass, 1983). Techniques of shaded relief have been used in cartography to produce the illusion of a 3-dimensional relief map (Yoeli, 1965). In the case of DEM's, shaded relief images and terrain derivative maps (slope, aspect and curvatures) have largely demonstrated their usefulness for lineaments and fault extraction (Ganas *et al.*, 2005). Linear features that can be extracted from DEMs often provide useful information for scientists.

The term "lineament" is one of the greatest generally used standings in geology. A lineament is any wide-ranging linear surface on a planet, as a fault line or fracture line. Hobbs (1904) first used the term lineament to define a significant line of landscape of Basement rocks. O'Leary *et al.* (1976) described the term lineament as a map able, simple or composite linear feature of a surface whose parts are aligned in a rectilinear or slightly curvilinear relationship and which differs from the pattern of adjacent features and presumably reflects some sub-surface phenomenon. Lineaments can be defined as linear topographical or tonal features on the terrain representing zones of structural weakness (Williams, 1983). Encouraging straight lineaments, interpreted as linear ridges, scarps, ridges, troughs and crater (light toned lineaments) and negative straight lineaments, representing joints, faults, and shear zones (dark toned lineaments). The determination of this research is to explain the capability of shaded relief images with multidirectional of the light foundations derived from digital elevation module for

lineament extraction (positive and negative lineament extraction).

## PHYSIOGRAPHY OF THE STUDY AREA

The study area is situated in the Central part of Tamil Nadu, India, about 1316.77 sq. km, between 78°09'00" E and 10°30'00" N and 78°09'00" E and 10°11'00" N. The hills form a compact block consisting of several hill ranges, and tangled ridges and Valleys running in the northeast and southwest directions in Parts of Tirchirappalli, Madurai, Dindigul, Pudukkottai and Sivaganga districts of Central Tamil Nadu. It falls in the survey of India Toposheet 57J/2, 3, 4, 6, 7 and 8 on 1:50,000 scale. The mean maximum and minimum temperatures are 34.2 °C and 19 °C. The annual average rainfall ranges from 512 to 1150 mm, both from the northeast and southwest monsoons. Topographically, the area is undulating with an altitude varying from 100 to 950 m. The rocks of study area are chiefly Charnockite, Quartzite and gneisses/granitic in composition.

## AIM AND OBJECTIVES

The present study is mainly focused,

- To extract automated lineaments using Landsat 8 satellite image with the help of PCI Geomatica software.
- SRTM DEM (90 m spatial resolution) has been used to prepare shaded relief map with 8 different azimuth angle respectively (0°, 45°, 90°, 135°, 180°, 225°, 270°, 315°) Solar Elevation 30°.
- To identify the structural trend lines, fold and fault maps extracted from the shaded relief.
- Rose diagram has been prepared to identify the orientation of lineaments using Rockworks software.

- Field visit has also been done to identify the geological structure, trend lines, lineament orientation and different rock types.

## MATERIALS AND METHODS

The geological map of the study area (Figure b) has been digitized from geological resource maps prepared by Geological survey of India (GSI)

### Data Dispensation

The environment of elevation data is constant, not separate. However, due to the limitation of recent technology, DEM data can be displayed in forms, i.e., grid, contour, profile, and TIN (Triangulated Irregular Network) which are not completely continuous. In this study, these data are displayed in the form of grid. The DEM was acquired from contour map and was originally generated by digitize the contour lines and give the contour lines the height value they represent, then converted it into grid form.

The DEM was geo-rectified using topographic maps with points collected at road intersections and other landscape features throughout the area. Shaded relief images were derived from a Digital Elevation Model (DEM) with a resolution of 30 meters are used for linear extractions. In order to identify linear topographic features from the DEM, eight shaded relief images were generated. The first step is the production of eight separate shaded relief images with light sources coming from eight different directions. The first shaded relief image created had a solar azimuth (sun angle) of 0°, and a solar elevation of 30°.

An ambient light setting of 0.20 was used, which produces a good contrast. The ambient light setting is simply a scaling factor in the imagine topographic program (Erdas, 1998). The other seven shaded relief images were created with seven contrasting illumination directions 45°, 90°, 135°, 180°, 225°, 270°, and 315°. The second

Figure 1: Study Area

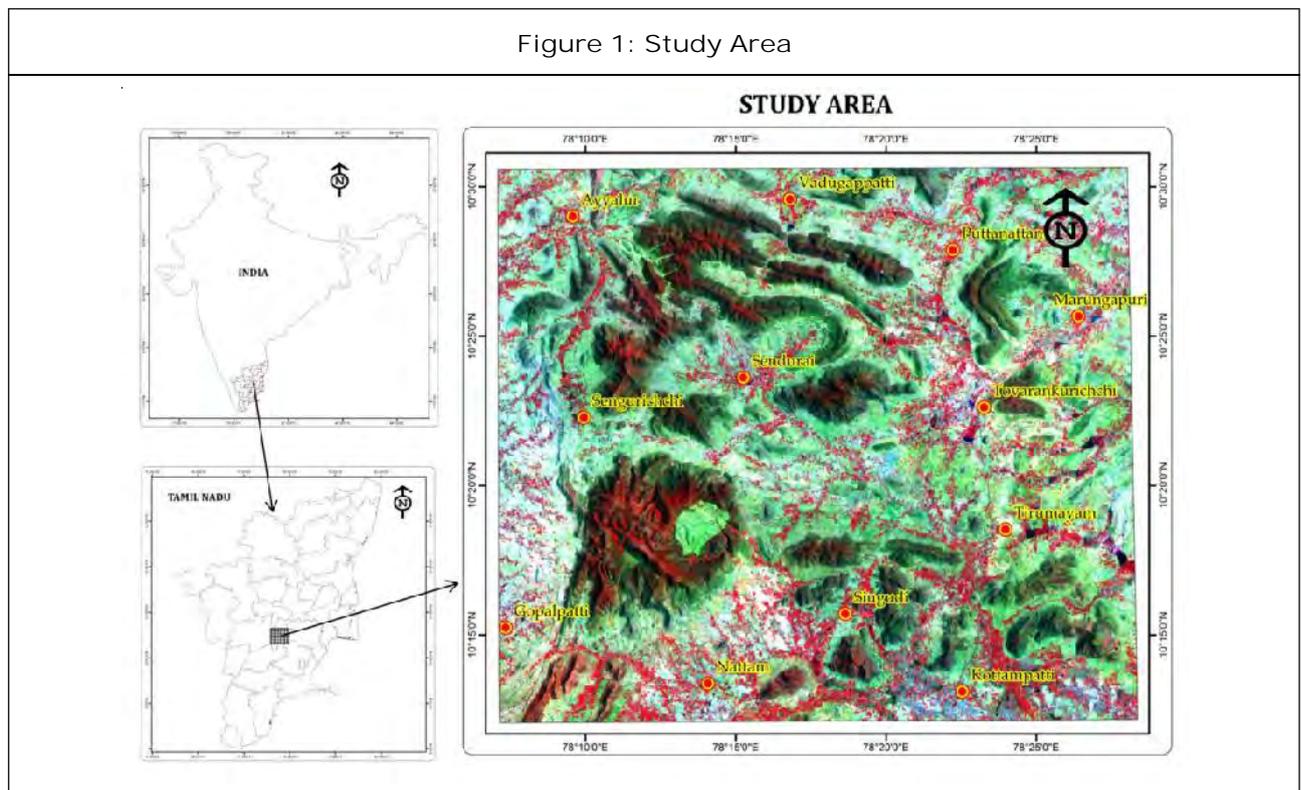


Figure 2: Field Survey

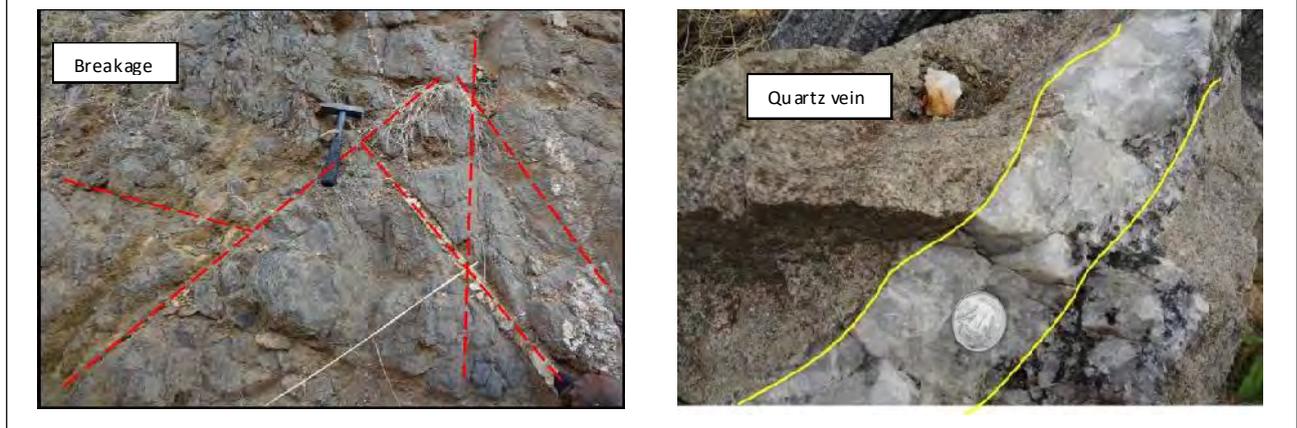


Figure 3: Lithology Map

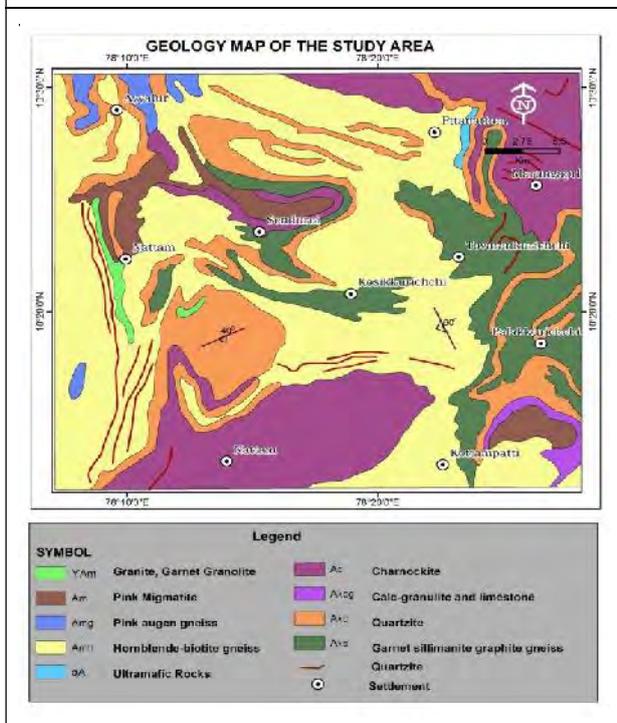
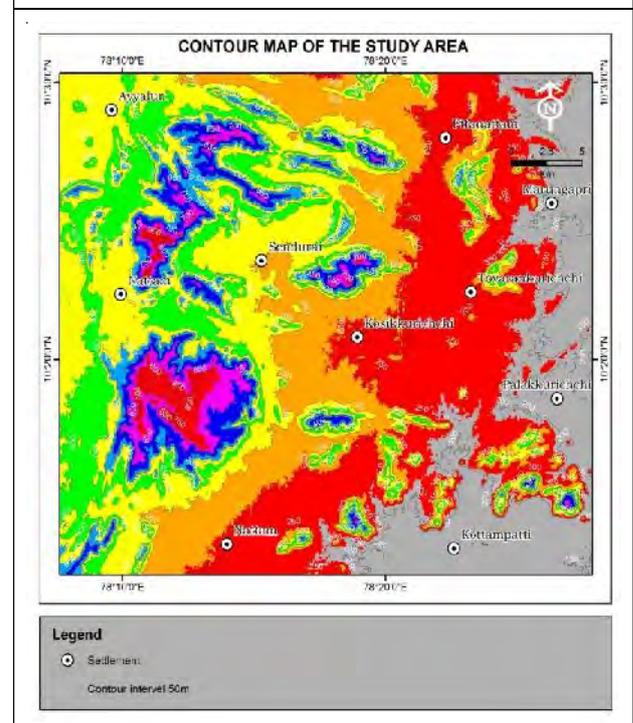


Figure 4: Contour Map



step is to combine four shaded relief image to produce one shaded relief image, for this purpose, the combinations of the four shaded relief maps are computed by using GIS overlay technique, where the first four shaded relief images are overlaid to produce one image with multi-illumination directions (0°, 45°, 90°, and 135°) and the second overlay is to produce one

image with multi-illumination directions (180°, 225°, 270°, and 315°). Finally, those two images have been used for automatic lineaments extraction over the study area.

### Lineament Extraction

The lineament extraction process of PCI Geomatica software comprises of edge detection,

Figure 5: Lineament Map

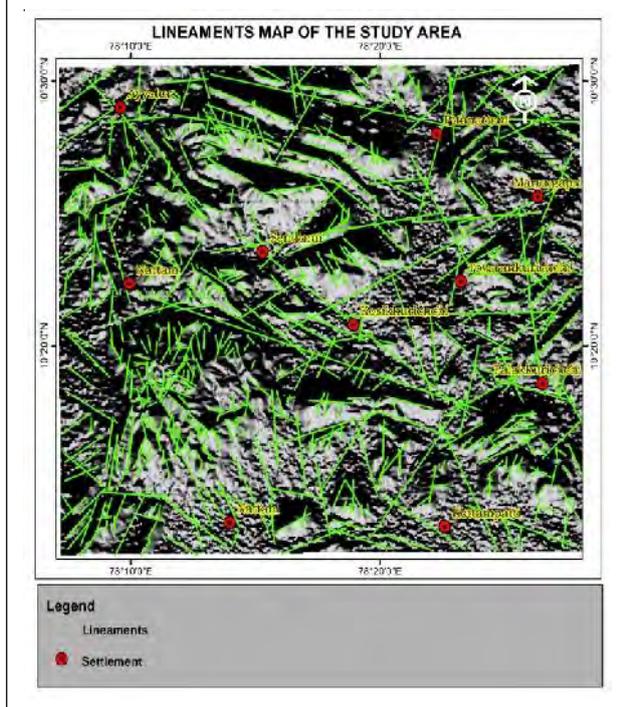


Figure 6: Structural Trend Line

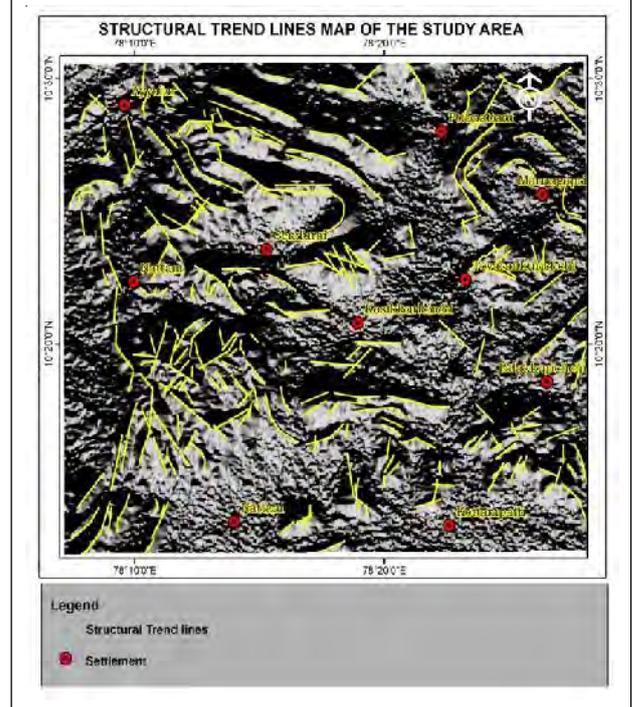
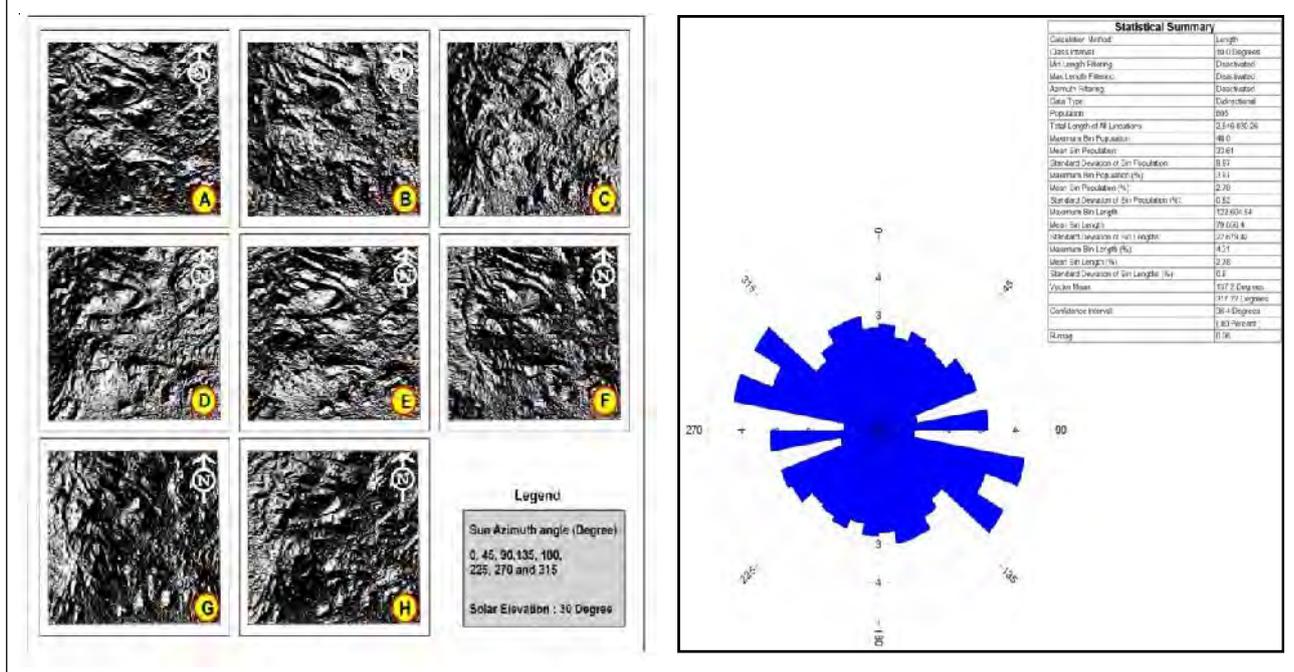


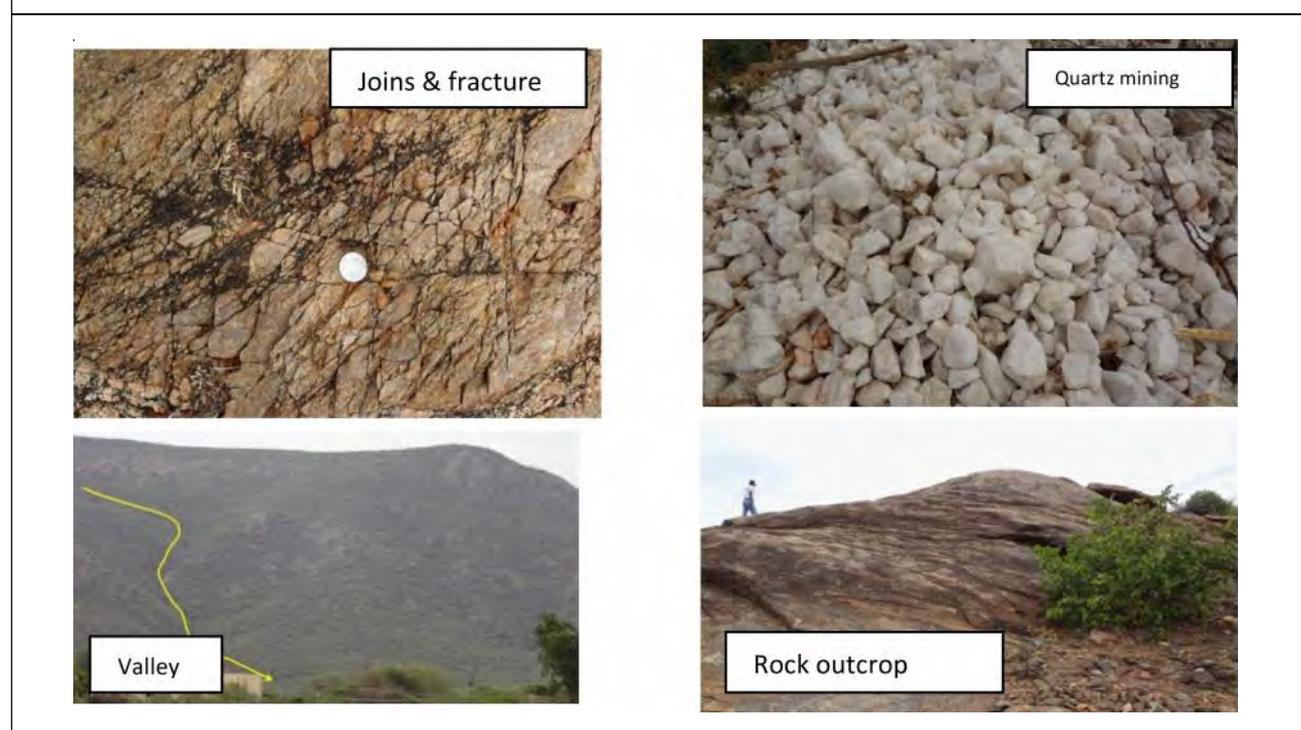
Figure 7: Shaded Relief and Rose Diagram



thresholding and curve extraction steps (PCI Geomatica, 2001). These steps were carried out

over two shaded relief images under the default parameters of the software as follows:

Figure 8: Field Survey



## CONCLUSION

In this present research paper the lineaments in the area of Central Tamil Nadu were automatically extracted using the module LINE of PCI Geomatica from two different sensors, SRTM and LANDSAT 8. A comparison was made between the different bands to select the best bands for lineament extraction. A methodology for lineament extraction and analysis is developed. This methodology has been proven as a suitable method for lineament extraction and analysis by comparison with the geological data for the Central Tamil Nadu. The density map of lineament indices and rose diagrams of the extracted lineaments indicate the same geological structure as reported before. The density map of average length of lineament can be used to define the fracture zone in the study area.

By comparing with drainage anomaly and lineament anomaly map also confined that the

major force acting in NE-SW direction. Since the fold axis are oriented in NW-SE direction the major force acting perpendicular to the fold axis. Similarly the lineaments are analyzed parallel to the major force direction which evident to the tectonic setup of the terrain. Regionally, in the entire south India the major force act in EW direction which results in NS lineament are Released fractures and EW lineament are Extensional fractures. Drainage and lineament density maps reveal that Maxima was in NE-SW directions

Trend line map reveals that, Fold axes are fall on NW-SE directions, Fold style map with lineaments and Structural trend line reveals that, Force may act in NE-SW directions. From that Regional force acted in NE-SW directions N-S and E-W lineaments are shear fractures, NE-SW lineaments are extensional fractures, and NW-SE lineaments are released fracture

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