IJRSG
EXPLORING INNOVATIVE TECHNICAL RESEARCH

International Journal of Remote Sensing & Geoscience (IJRSG)
www.ijrsg.com

EVALUATION OF THIRD DIMENSION OF FRACTURE CONTROLLED LINEAMENTS FOR PROSPECTING GROUND WATER OF PART OF SOUTH INDIA THROUGH REMOTE SENSING & GIS

P.Venkata Ramireddy, Team Leader (GIS) 1; G.V.Padma, Team Leader (GIS) 2; N. Balayerikala Reddy, Professor 3
1&2 Andhra Pradesh Space Applications Centre (APSAC), Planning Department, L-Block, A.P.Secretariat, Hyderabad
Department of Geology, Sri Venkateswara University, Tirupati-517502, Andhra Pradesh

Abstract

As the available surface water resources are too disproportionate to cope up man's needs, the man has aggressively and competitively started mining the ground water reservoirs all over the world. In the initial phases of ground water exploration, the man has exploited all the visibly seen ground water provinces of the earth for his needs. As that too has got exhausted, he was forced to search for more and more hidden ground water reservoirs. It is widely accepted that all over the world, the ground water is controlled by the primary porosity in sedimentary formations and by the second porosity in the hard rock areas. Though it has been a tuff task to went for ground water in hard rock aquifer systems, hence the man has been using all the possible and available techniques like Hydro geological mapping Geophysical exploration, Hydro geochemical exploration and the high technology like Remote sensing in the recent years . Lineament analysis for ground water exploration in study area has considerable importance as joint/fractures and Faults serve as conduits for movement of groundwater. Hence in the Remote Sensing technology the lineament analysis is an important one for ground water prospecting.

Key words: Lineaments, Isoresistivity data, Remote Sensing, GIS.

Introduction

Lineaments are defined as linear and curvilinear features of tectonic origin, Observed to a considerable distance on the earth surface. Hobb (1912), was the first person to coin the term, subsequently many people have carried out work on the lineaments. After the advent of the modern remote sensing technology, the research on lineaments has taken a steep rise owing to the better appreciation of such linear features in space borne photographs. In the Indian subcontinent too, quite a lot of people have carried out extensive work on lineaments. Even after such varied and deep seated work the definition of lineaments is still an enigma and different people are using different nomenclature for the lineaments. However the Indo-US work shop on "Regional Geophysical lineaments has defined lineaments as " a lineament is a regional scale linear or curvilinear feature, pattern or change in pattern that can be identified in a data set and attributed to a geologic formation."

Whether one agrees with the definition or not, it is definitely a conspicuous feature observed on the terrestrial surface which has also got very deep geological significance. the lineaments are found to have direct control over tectonism and development of geologic basins, magmatic episodes, metallogenic events, oil bearing structures, geothermal springs, seismotectonism and also ground water and as a result it has become one of the very important geological features to be studied for resource inventory programs. In the present study, an attempt has been made to evolve a third dimension of fracture controlled lineaments and analyze the depth extension of lineaments for prospecting ground water based on remote sensing and GIS techniques.

Study area

The study area consist three major villages in i.e. Kiranur, Cavery Nagar and Perungalur located in the south western part of Tamilnadu. It lies between 10^0 45' to 10^0 67' N latitude and 78^0 75' to 79^0 00' E longitude shown in Figure-1. It is generally hot and dry except during the winter season. The maximum and minimum temperature for the study area is 40 ^{0}C and 16 ^{0}C. The area receives an average annual rainfall of about 385 mm. The surface runoff goes to stream as instant flow. Rainfall is the direct recharge source and the irrigation return flow is the indirect source of groundwater. The study area depends mainly on the north-east monsoon rains which are brought by the troughs of low pressure established in the Bay of Bengal. Most of the farmers depend on the groundwater for their irrigational needs.

Data products used

IRS-1D satellite data have been used in conjunction with Survey of India toposheets. Satellite data were collected and registered to Survey of India topographical sheets at

1:50,000 scale using Erdas Imagine image processing Software and contour maps have been prepared by using SURFER and Arc GIS softwares. Resistivity data for 21 locations within the study area have been used.

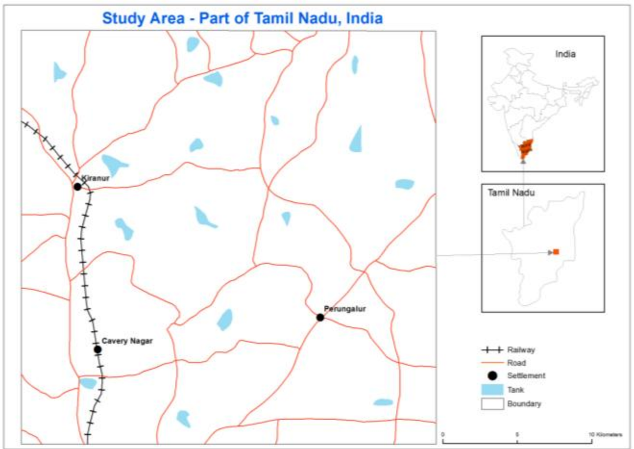

Figure 2. Study Area

Methodology

The Indian Remote Sensing Satellite (IRS) ID, Linear Image Self-Scanning (LISS) III of geocoded False Colour Composites (FCC), generated from the bands 2, 3 and 4 on 1:50,000 scale was used for the present study. Lineament mapping is normally undertaken based on geomorphological features such as aligned ridges and valleys, displacement of ridge lines, scarp faces and river passages, straight drainage channel segments, pronounced breaks in crystalline rock masses and aligned surface depression for the study area, the main interest was topographically negative lineaments, which may represent joints, faults and probably shear zones.

Grid map generated by dividing the study area into 729 grids with 1sq.km each and On the basis of lineament map, lineament density diagram was prepared. Isoresistivity contours prepared for 10m, 16m, 20m, 26, 30m, 50m, 75m and 100m depths using surfer software and marking resistivity minima axes at different depths and transferring all such low axes of different depths to single overlay. After finding lineament density maxima axes and resistivity minima axis these two were manually integrated, to evaluate the depth persistence.

Results & Discussions

1. Lineament analysis

Lineament architecture

Lineaments are the linear, rectilinear, curvilinear features of tectonic origin observed in satellite data (Figure-2). These lineaments normally show tonal, textural, soil tonal, relief, drainage and vegetative linearities and curvi linearities in satellite data. All these linear features were interpreted in the satellite data and the lineament map prepared. In the present study area the lineaments fell in to four azimuth classes as E-W to ENE-WSW, NE-SW, WNW-ESE to NW-SE and NNW-SSE.

Lineament density pattern

The purpose of the lineament density analysis is to calculate frequency of the lineaments per unit area. The entire study area was gridded into 729 grids with 1 sq.km each. The lineament map was superimposed over grid map and the total length of the lineaments were counted for each grid plotted in the corresponding grid center and contoured using Surfer software. These contours were designated as lineament density diagram.

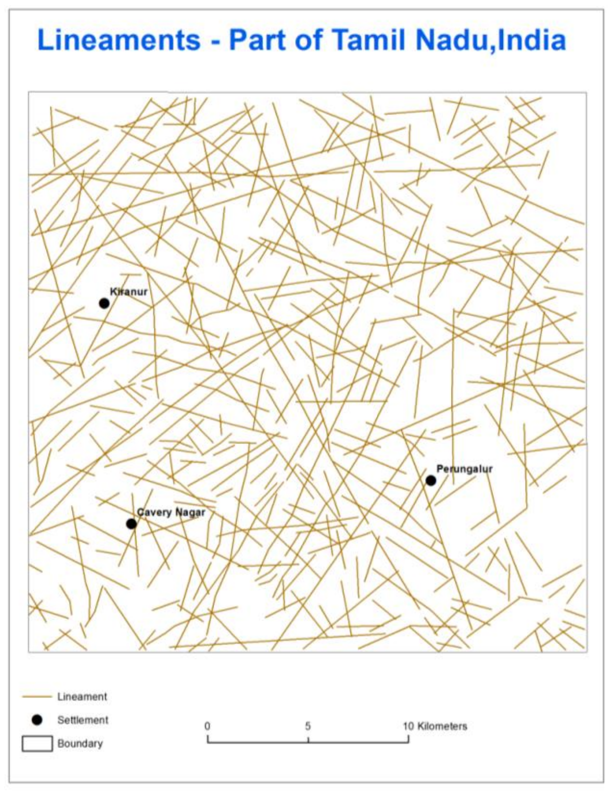

Figure 2. Lineaments map

Lineament anomaly pattern

From the shape of the lineament density contours (Figure-3) the linearity maxima axes were drawn along the crest of the contours of elliptical shapes with maximum value in the core and successive lesser and lesser values encircling them. The anomaly axes so derived for the lineament density diagrams predominantly show in N-S, NE-SW and NW-SE directions. These directions indicate that the maximum number of lineaments is aligned only along these directions.

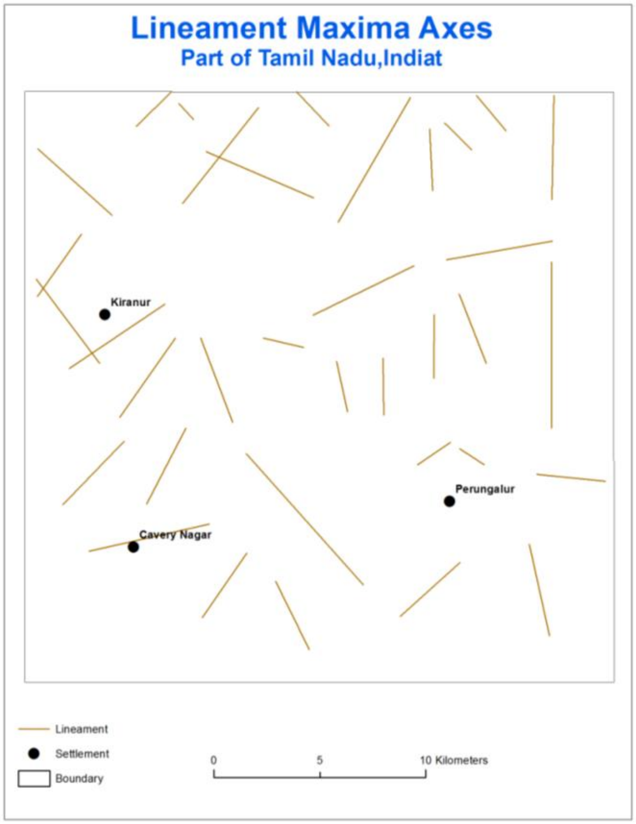

Figure 3. Lineament maxima axes

2. Analysis of Geophysical Resistivity data

Isoresistivity contours

For the present study, already existing resistivity data for 21 locations at 10m, 16m, 20m, 26m, 30m, 50m, 75m and 100m, depths have been used. By using the resistivity data, spatial depiction of depths have been mapped using surfer software with creation of isoresistivity contours for 10m, 16m, 20m, 26m, 30m, 50m, 75m and 100m.

Deduction of Resistivity minima axes

From the shape of the resistivity contours the minima axes were identified as the anomaly axes. This was similarly drawn along the trough of the elliptical contours with lower contour values at the core and next successive higher values in circulating the same. The anomaly axes so derived for the resistivity diagrams predominantly show in E-W, N-S, and NW-SE, NE-SW directions.

Resistivity minima axes at different depths

- 10 M Depth - At 10m depth resistivity minima axes predominantly appear in NE-SW and NW-SE directions.
- 16 M Depth - At 16m depth the resistivity minima axes show same directions as 10m depth.
- 20 M Depth - At 20m depth the resistivity minima axes predominantly appear in NW-SE and NNE-SSW directions.
- 26 M Depth - At 26m depth the resistivity minima axes show in NW-SE, NE-SW, N-S and ENE-WSW directions.
- 30 M Depth - At 30m depth the resistivity minima axes show NW-SE, NE- SW, N-S and ENE-WSW orientation.
- 50 M Depth - At 50m depth the resistivity minima axes show NW-SE, NE-SW, ENE-WSW and NNW-SSE directions.
- 75 M Depth - At 75 m depth the resistivity minima axes show NW-SE, NE- SW, NNW-SSE and ENE-WSW orientation.
- 100M Depth - At 100m depth the resistivity minima axes show same as 75m depth directions.

3. Integration of Lineament maxima anomaly with Resistivity minima anomaly

Before integrating the study area was divided into 4 segments (1, 2, 3, and 4) and manual integration was done between lineament maxima anomaly axes with resistivity minima axes. In segment 1 ENE-WSW trending lineaments appear to extend up to 26m, 50m depths, in segment 2 NW-SE trending lineaments appear to extend 50m, 100m depths, in segment 3 NNW-SSE lineaments appear to extend 10m to 100m depths and in segment 4 NNE-SSW lineaments appear to extend 26m, 30m, 50m, 75m and 100m depths(Figure -4).

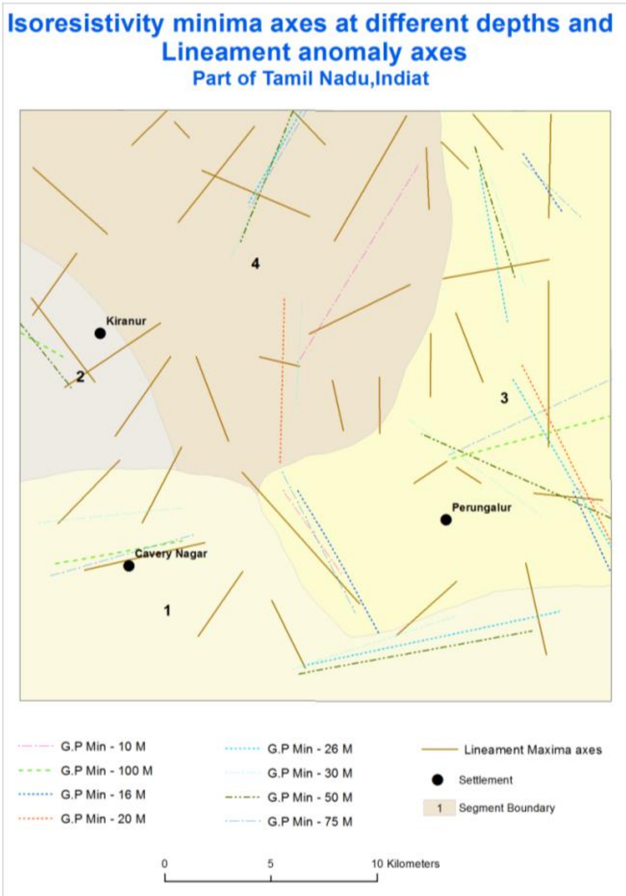

Figure 3. Isoresistivity minima axes at different depths and Lineament maxima axes

Conclusions

Overall the study has lead into the NNW-SSE trending lineaments extend up to 100 m depth with eastern part, NNE-SSW trending lineaments extend up to 75 m depth with NW part and ENE-WSW trending lineaments extend up to 75m depth with south part of the area. Finally a general conclusion was drawn that the NNW-SSE, N-S and NNE-SSW lineaments in general appears extended to deep depths.

The lineament mapping is a systematic effort and has been prepared considering major controlling factors that influence the water yield and depth of groundwater. The map depicts isoresistivity minima axes at different depths, which are essential basis for planning and execution of groundwater exploration. The derived information, depicted in the form of a prospect map would provide first hand information to local authorities and planners about the areas suitable for searching groundwater followed by its suitable exploration.

Acknowledgments

The authors are thankful to IJRSG Journal for the support to develop this document. We would like to thank anonymous reviewers for their valuable suggestions which have improved the manuscript enormously.

References

[1] T. Subramani et al (2014) 'Identification of Soil Erosion Prone Zones Using Geomatics Technology in Parts of North Arcot and Dharmapuri District,' Int. Journal of Engineering Research and Applications ISSN: 2248-9622, Vol. 4, Issue 12(Part 3), pp.150-159, December 2014.

[2] Balachandar.D, Alaguraja.P, Sundaraj.P, Rutharvelmurthy. K, Kumaraswamy.k (2010) 'Application of Remote Sensing and GIS for Artificial Recharge Zone in Sivaganga District, Tamilnadu, India,' International Journal of Geomatics and Geosciences, Vol.1, No.2.

[3] M.A.Khan and P.C. Moharana (2002) 'use of remote sensing and Geographical Information System in the delineation and characterization of Ground water prospect zones,' Journal Indian society of Remote Sensing, Vol.30, No.3, pp.131 142.

[4] Ravindran.K.V. and Jeyaram.A (1997) 'Ground water prospects of Shahbad Tehsil, Baran District, Eastern Rajasthan, A Remote Sensing Approach,' Journal Indian society of Remote Sensing. Vol.25, No.4, pp.239-246.

[5] R.Jayakumar and S.M.Ramasamy (1996) 'Groundwater targetting in hard rock terrains through geomorphic mapping, a case study in part of South India,' Asian Pacific Remote Sensing and GIS journal, Vol.8, No.2, pp: 17-23.

[6] NRSA (1995), 'Integrated Mission for Sustainable Development (IMSD),' Technical guidelines, National Remote Sensing Agency, Hyderabad.

[7] Prakash.S.R. and Mishra.D (1991) 'Identification of groundwater prospective zones by using remote sensing and geoelectrical methods in and around Saidnagar area, Dakar block, U.P.,' Journal Indian society of Remote Sensing, Vol.21, No.4, pp.217-227.

[8] Drury.S.A (1987) 'Image interpretation in Geology,' Allen and Unwin Publishers, London.

[9] Todd.D.K (1980) 'Ground water Hydrology,' Second Edition, John Wiley and Sons Pvt. Ltd.

[10] Billings P Marland (1974) 'Structural geology' (3rd edition)

[11] Palanivel.K, 'Remote Sensing and GIS in water resources prospecting and conservation, parts of Western Ghats, Tamil Nadu, India,' A Ph.d., Thesis in Earth Sciences, Bharathidasan University.

[12] S.M.Ramasamy, P.C.Bakliwal, and A.K.Grover, 'Use of remote sensing in identification of possible target areas for Groundwater, Hydrocarbons and Minerals

in the Thar Desert, Western India,' Trends in Geological Remote Sensing (Ed.), Rawat Publications. Pp.184-198.

[13] S.M.Ramasamy and P.C.Bakliwal, 'Groundwater targeting of Banded Gneissic Complex, Rajasthan through Remote Sensing,' Trends in Geological Remote Sensing (Ed.), Rawat Publications, pp: 231-243.

[14] Hobbs, W. H. (1912). 'Earth Features and Their Meaning: An Introduction to Geology for the Student and General Reader,' Macmillan Co., New York, 347.

Biographies

P.VENKATA RAMIREDDY received the M.Sc degree in Geology from the Sri Venkateswara University, Tirupati, Andhra Pradesh and received M.Tech degree in Remote Sensing & GIS from Bharatidasan Unversity, Trichy, Tamilnadu. Currently working as a Team Leader at Andhra Pradesh Space Applications Centre (APSAC). He has vast experience in the field of Remote Sensing & GIS applications in various natural resources and worked under various organizations for different research projects. Email: pvramireddy19@gmail.com