APPLICATION OF REMOTE SENSING FOR GEOTHERMAL EXPLORATION IN SOUTHERN INDIAN PENINSULA

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SUMMARY - The study of Thematic Mapper band 6 data of northern part of Tamil Nadu in conjunction with IRS 1-A imagery data, temperature data of wells and the heat flow data indicates that there is a possibility of getting geothermal fields in Tamil Nadu along N-S, NNE-SSW and NNW-SSE tending lineaments.

1. INTRODUCTION

The states of Tamil Nadu and Kerala form the Southern tip of the Indian Peninsula. In the Indian Scenario, these two states do not possess any major metallogenic provinces and such absence is attributed to the polyphase deformation and the multiple deformation by the geologists. Hence, in the absence of such revenue yielding metallogenic deposits, the attention of the geoscientists has obviously turned towards the alternate resources. One such significant alternate resource is the geothermal resource which can be used for multiple purposes. Ravishankar(1988) has prepared the heat flow map for the entire Indian Subcontinent and the adjoining regions and in which he has mentioned that more than 90% of Tamil Nadu state is unfavourable for any geothermal resources and he has further indicated that the possibilities of striking the geothermal resources are there only in Tanjore old delta regions and also around Madras city. He has primarily based his observations only on the heat flow measurements carried out through conventional techniques and also the heat flow data which have been generated geochemically from the SiO_2 content of the groundwater samples by duly using Swanberg and Morgan's(1978) equation.

In the present study, an attempt has been made to spot out the regional locales for the possible geothermal resources using satellite based remote sensing data and the groundwater temperature measurements. Such analyses reveal that the state of Tamil Nadu needs a fresh look for hitting the geothermal provinces.

2.GEOLOGY OF THE AREA

The state of Tamil Nadu is occupied by mainly Precambrian group of metamorphites represented by charnokites, granulites, gneisses, migmatites, Kondalites and ultra basic suite of rocks. The eastern fringe of Tamil Nadu is represented by sedimentary rocks belonging to Cretaceous and Tertiary formations (Fig.1). Hence geologically the state of Tamil Nadu is favourable for the geothermal resources as the region has witnessed multiple magmatic episodes coupled with repetitive deformatic events

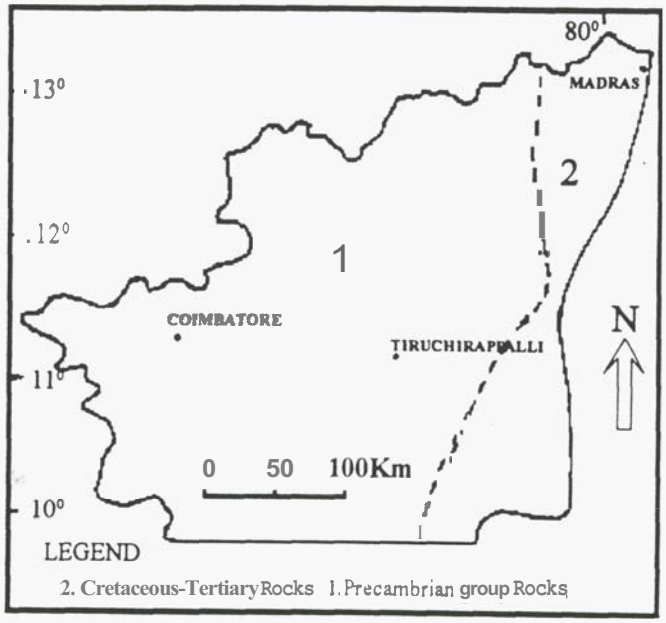
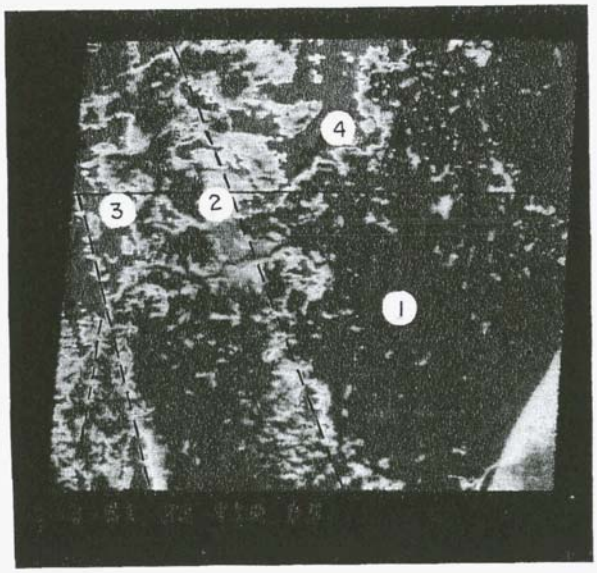


Figure 1- Geology map of part of Tamil Nadu, India

3. EVALUATION OF GEOTHERMAL RESOURCES

3.1 General

Hence an integrated analysis was carried out to evaluate the feasibility of targeting the geothermal pockets. In the study, the digitally enhanced TM band 6 thermal data was used for mapping the different zones of rock emissivities. The IRS-1A satellite data was interpreted to bring out the overall lineament pattern with special emphasis to Pleistocene lineaments. The temperature data of groundwater from over 250 wells located in various parts of Tamil Nadu was collected and analysed for the temperature dispersal pattern. Finally all the above said data bases were integrated and the regional targets for the deeper search of Geothermal resources were identified.



LEGEND
1. Region of maximum thermal emissivity
4. Minimum emissivity
2-4 Thermal emissivity in decending order
Thermal anomaly axis

Figure 2 - Thermal imagery of part of Tamilnadu, India

3.2 Analysis of Thematic Mapper Band 6 Data

The Thematic Mapper band *6* data (spectral range 10.5 to 12.5μm) for the northern part of Tamil Nadu was analysed using VAX 11/780 computer system. In this data, the different thermal emissivity of the rocks were coded in different gray values ranging from 0-255. From such data density sliced pictures were generated, through which the different spectral ranges were grouped into a number of classes and given different colour coding. The colours were given in such a way that red colour denotes the regions of maximum spectral values/emissivities and the dark black colour indicates the zones of minimum spectral grades. Such density sliced images generated for different scenes of TM data were mosaiced and subsequently analysed (Fig.2).

Using such density sliced data, the axes of high thermal emissivities were marked. Such axes of high thermal emissivities show a long and linear or elliptical zones filled with the red colour in the core and surrounded by yellow and green colours successively or yellow colour was observed in the core encircled by green colour and then by blue colour zones (red colour indicates the maximum and yellow, green and blue were successively indicating. the nest, lower thermal values and the zones of black colour indicates the emissivity minimum as stated earlier.)

Such thermal emissivity maxima axes mapped were invariably exhibiting NNE-SSW and N-S trending linear bodies sometimes extending for over 200 to 300 Kms. (Fig.3).

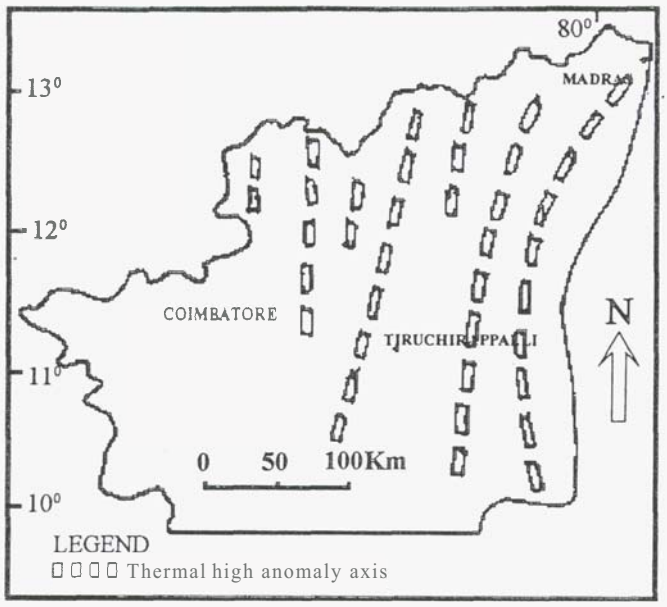


Figure 3- Axes of high thermal emissivities (interpreted from TM band *6* data)

3.3 Analysis of IRS 1A Imagery and Lineament Mapping

The raw and the digitally enhanced IRS-1A imagery was interpreted and lineament map was prepared (Fig.4).

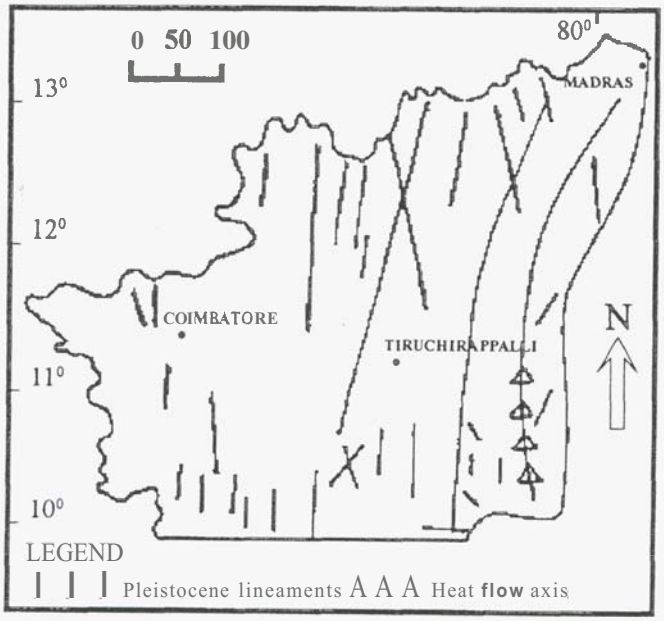


Figure 4 - Lineaments

Ramasamy et.al.,(1987) have analysed the lineaments/ fractures of Tamil Nadu and classified the lineaments into 3 major azimuthal groups such as

1. ENE-WSW trending extensional fractures/lineaments
2. NE-SW trending dextral and WNW-ESE trending sinistral failures and
3. NNW-SSE aligned release fractures/lineaments

Ramasamy and Balaji(1993) have brought out one more set of lineaments with NNE-SSW to N-S orien-

tation. The present study has once again substantiated the earlier findings. Ramasamy and Balaji(1993) have also demonstrated that amongst the above four set of lineaments, the fourth set, that is the NNE-SSW to N-S trending lineaments are younger in age and also seismically active, as they express striking coincidence with earthquake epicenters and also the drainages showing frequent anomalies along them.

3.4 Analysis of Groundwater Temperature Data

The groundwater temperature data was collected from over 250 wells. The temperatures vary from 24° C to 44° C . In order to have an enhanced picture about the temperature variations in the area of study, such temperature data was rescaled to 0 to 255 by using the formula

$$\frac{X - X_{min}}{X_{max} - X_{min}} \times 255 \quad .. (1)$$

where

X - temperature of particular well location

X_{min} - minimum temperature observed amongst these 250 wells

X_{max} - maximum temperature observed amongst these 250 wells

Such rescaled values were plotted in their respective locations of the wells and contoured. Such contours have normally shown regional elliptical shapes, ofcourse with occasional circular pattern. The linearity of such contours were identified' as anomaly axes and wherever such temperature maxima were observed along with elliptical or linear shaped contours, those were interpreted as temperature maxima axes (Fig.5). Such set of identified axes too show a general NNE-SSW and N-S orientations.

3.5 Analysis of Heat Flow Data

Scanty information is available on the heat flow data for the area of study. Ravishankar(1988) has presented the heat flow data for the part of east coast of Tamil Nadu collected from G.S.I exploratory boreholes and also NGRI and ONGC published information. The heat flow data so reported by him is also varying from 100 to 125 mw/m². It is observed that such heat flow data is almost falling only along N-S trending lineaments (Fig.4).

4. INTEGRATED STUDIES AND DISCUSSIONS

The analysis of the thematic mapper thermal band 6 data shows that, the thermal emissivity maxima is aligned only in N-S and NNE-SSW directions (Fig.2 and 3). The studies carried out by Ramasamy et.al.,(1987), Ramasamy(1990) and Ramasamy and Balaji(1993) show that amongst all the four sets of lineaments, the N-S, NNE-SSW and also NNW-SSE trending lineaments are younger in age. Ramasamy and Balaji(1993) have further demonstrated that such set of younger lineaments are seismic prone since there is a positive correlation between such younger lineaments and earthquake data, They also recorded evidences of tectonism in the form of drainage reversals, drainage deflections and anomalous compressed meanders, wherever such younger lineaments intersect the drainage systems. Now, in the present study, thermal band data of Thematic Mapper exactly match with such younger set of lineaments (Fig.6). Ravishankar(1988) has also made similar observations that the most of the heat flow anomalies of the India subcontinent were matching with zones of seismic vulnerabilities.

The temperature dispersal pattern of the groundwater also seems to show a N-S anomaly which is well matching with such N-S trending lineaments (Fig.5 and 6).

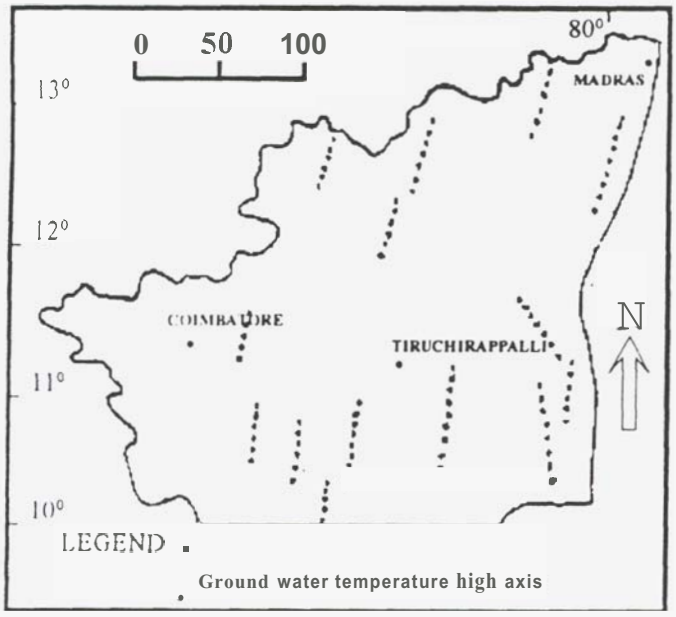


Figure 5 - Ground Water Temperature Anomaly Axis

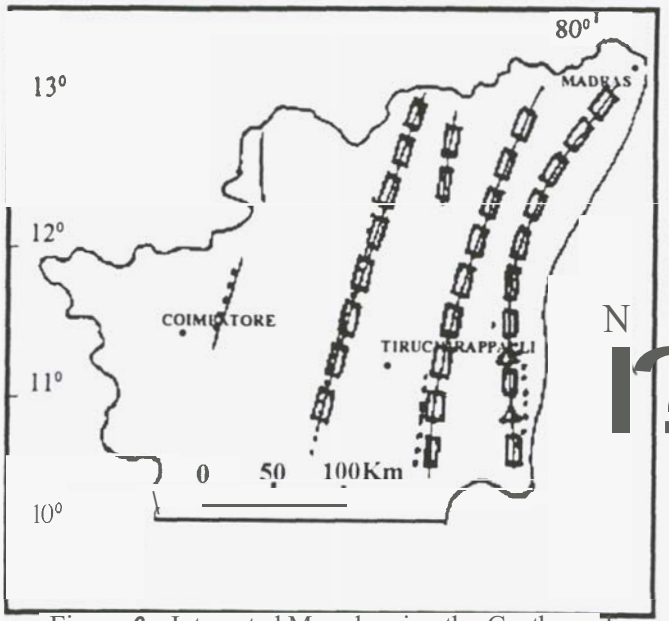


Figure 6 - Integrated Map showing the Geothermal Linears

In addition the integration of heat flow data (though available less in numbers) recorded from the east coast of Tamil Nadu is falling along one such N-S trending lincanicnt extending from Madras city in the north to point Calimere in the south.

5. CONCLUSIONS

Thus the above study shows that there arc possibilities for the geothermal resources in Tamil Nadu and the N-S, NNE-SSW and NNW-SSE trending younger lineaments need a thorough evaluation. The heat flow measurements both through conventional techniques and also through computation of SiO_2 dara of groundwater data will give a clear picture in targeting the geothermal resources.

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