*Journal of Science and Technology*
*ISSN: 2456-5660 Volume 06, Issue 04, July-August 2021*

*www.jst.org.in* *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182*

# *Lineament Mapping Using Remote Sensing and GIS Techniques in Part of WRC-1 Watershed, Chargarh River Basin, Central India*

***A. D. Fuladi* and M. S. Deshmukh*****

**Assistant Professor, S. S. E. S. A's Science College, Nagpur (440012), M.S., India.*

***Assistant Professor (Mentor), Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur-(440001), M.S., India.*

***Email:*** *apurva.8july@rediffmail.com*

***To Cite this Article***
*Manish S. Deshmukh* and Apurva D. Fuladi, "**Lineament Mapping Using Remote Sensing and GIS Techniques in Part of the WRC-1 Watershed, Chargarh River Basin, Central India**, Vol. 06, Issue 04, July-August 2021, pp172- 182.*
***Article Info***
*Received: 24-08-2021 Revised: 26-08-2021 Accepted: 28-08-2021 Published: 31-08-2021*

## ABSTRACT

The study comprises use of remote sensing and Geographic Information System (GIS) techniques for the identification of groundwater resource potential in response to the lineaments. The remote sensing IRS-Resource Sat-2, LISS-III false colour composite (FCC) Satellite images were utilized to conduct lineament data analysis of the Chargarh River Basin, especially with respect to the lithological setup and density and frequency of the lineaments. The area is covered by the Deccan basalt lava flows in the northern part and Quaternary alluvium in the southern part of the watershed. In all 116 lineaments are exposed in the central and northern part of the watershed. To study the significance of lineament trend and lineament intersection, lengths of the lineaments and intersections are considered with statistical analysis. It is observed that Tapi lineament has long and short fractures which has unique significance in the present study. The lineament/fracture analysis indicates a special structural pattern with orientation due North-South and East-West. In the watershed cross lineaments are dominant and the zones with high lineament intersections are feasible places for groundwater occurrences.

**Keywords:** Remote Sensing; GIS, Lineament; Joints; Fractures.

## INTRODUCTION

www.jst.org.in DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182

The Lineaments are lines that appear on satellite images and represent folds, fractures or faults in the subsurface. (Sabins, 2000; Mirosław, K., 2020); They are linear or curvilinear extended characteristics of a surface, whose components align in a straight or nearly straight line (O'Leary, et al., 1976). These features or geological structures can be represented on a variety of scales, ranging from regional to local to microscopic size. During recent years, remote sensing and geographic information systems (GIS) have developed as crucial technologies for providing information that is immensely useful for managing and monitoring natural phenomena, as well as comprehending regional geological setup with respect to the tectonics. The Salbardi fault, as well as the other nearby faults, provide crucial information on the tectonic history of the area. The region is located between the Salbardi fault and the ENE-WSW trending Son-Narmada-Tapti lineament (SONATA), an important tectonic element in the central Indian shield. (Acharyya, et al., 1998). The fault along Satpura foothill, connects the Tapi graben and the Satpura horst, is the most active member of the fault system in this area (Ravi Shankar, 1994; Chattopadhyay, et al., 2008, Manjare, 2013). The Salbardi fault is most likely an extension of the well-known Gavilgrah/Elichpur fault to the east. (Rajurkar, 1981, Manjare, 2017). According to Auden (1949) the fault is somewhere between Gawilgrah and extends to the north east. In different sections, it was referred to as the Gawilgarh fault, Elichpur fault, and Salbardi fault (Rajurkar, 1992, Saxena, 1994, Tiwari, 1985). The watershed is bounded by Satpura hill ranges due North, while Wardha river along the southern boundary of the watershed, which acts as a divide between Amravati and wardha districts of Maharashtra. Faults are weak spots in the earth's crust that are distinguished by geological features such as a distinct drainage network, lineaments and interactions between different Litho-tectonic units (Lillesand, et al., 1994). A lithological contact could potentially be indicated by the linear features. By integration of remote sensing data, geographic information system (GIS) technique and geological field data, reveals the characteristics of faults and fractures.

## STUDY AREA

The WRC- 1 Watershed, Chargarh river basin is included in Survey of India toposheets 55G/15, 55G/16, 55K/3 and 55K/4 and bounded by 77°45' to 78°05' E Longitude and 21°0 to 21° 25 N Latitudes, covering approximately 412 Sq.km area (Figure 1). The Chargarh River

*Journal of Science and Technology*
*ISSN: 2456-5660 Volume 06, Issue 04, July-August 2021*

www.jst.org.in *DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182*

originates in Satpura mountain and flows in North- West to South- East direction. The river flows through the Ghatladki, Khed and Udkhed village areas, with a general trend of South to

East and joins the Wardha River near Bhambora village, Morshi town, Amravati district, Maharashtra, India.

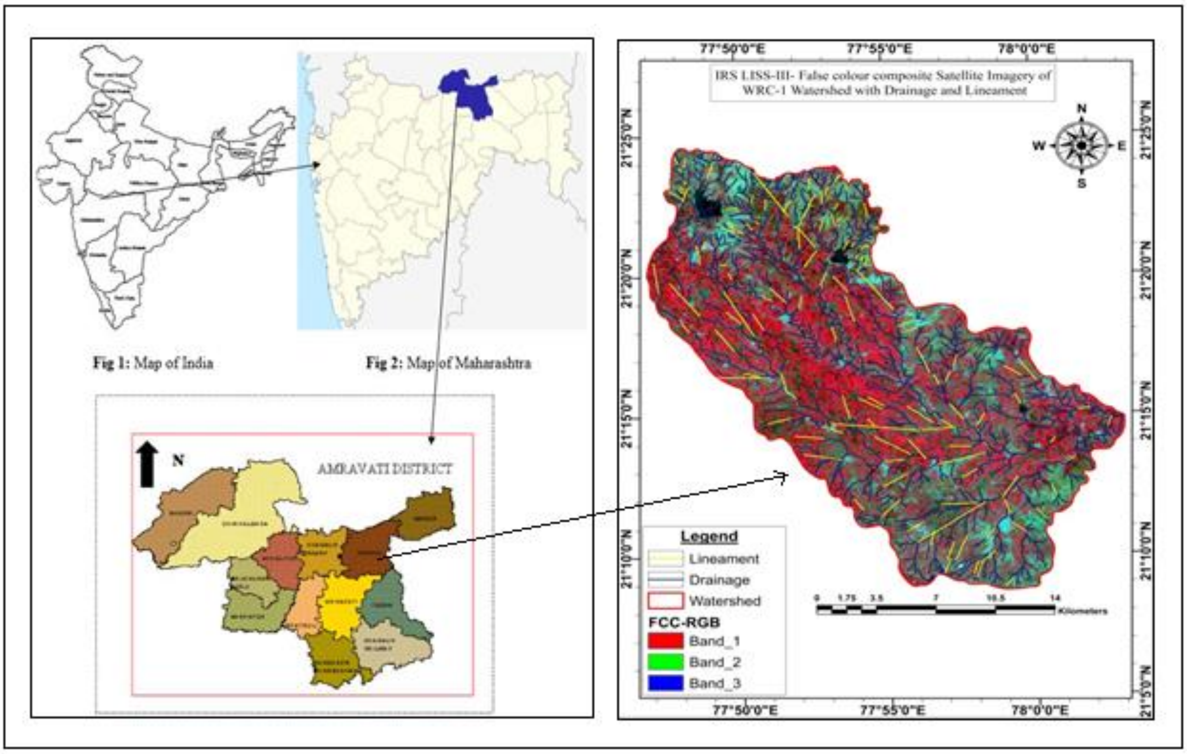


**Figure 1:** Location map of the study area and IRS, LISS-III false colour composite satellite imagery with superimposed drainage and lineaments (Fuladi and Deshmukh, 2020).

## METHODOLOGY

The study area is delineated and mosaiced on the basis of Survey of India topographic maps 55G/15, 55G/16, 55K/3 and 55K/4 of 1:50,000 scales. The Arc-GIS software was utilized with UTM, WGS-1984, 43N zone projection system, for the lineament extraction. The digitization of geological features IRS-Resource Sat-2, LISS-III false colour composite imageries (FCC) were utilized (Tile No. F43R15, F43R16, F43M03 and F44M04). The satellite data is used to demarcate lineaments of the area. The lineaments are digitized as line coverage and map projected to UTM projection in ArcGIS technique. In the satellite imageries, lineaments appear as straight lines or edges, contributing to tonal and textural contrasts on the

www.jst.org.in DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182

earth's surface.The stream segments are shortest lineaments known, measuring upto few meters to few km. in length. Drainage lines indicate linear valley trends, regardless of channel segment orientation or linearity. The scarps and fault line scarps indicate topographic breaks, which are

demarcated by the variations in the outcrops, presence of shadows in the images, changes in drainage pattern etc. The lineaments were categorized on the basis of lineaments length as micro: < 2km, minor: 2-10 km, medium: 10-100 km, major: 100-500 km, mega > 500 km. (Manjare, B.S.,2013; Ganesh Raj, 2003). The lineaments are also manually extracted and analyzed in order to identify distribution and other characteristics (Figure 1).The geological map is prepared on the basis of satellite imageries, field data and district resource map (DRM) of Geological Survey of India (GSI, DRM, 2001).

## GEOLOGY

The WRC-1 watershed is dominantly covered by the Deccan basalt lava flows of Upper Cretaceous to Eocene period and Quaternary alluvium (GSI, DRM, 2001). The Deccan basaltic flows belong to the Sahyadri Group, which is divided into three Formations viz: Chikhli, Karanja, and Ritpur Formations. A maximum of six lava flows are exposed in the Chikhli Formation which are non- porphyritic to moderately porphyritic in nature (GSI, DRM, 2001). The lava flows range in thickness from 45 metres to 130 metres. The Karanja Formation comprises 8 to 14 flows, which are mostly porphyritic and also non-porphyritic to highly porphyritic in nature. There are seven lava flows in the Rithpur Formation which are simple type, non- porphyritic with thickness variation 55 to 117 metres (DRM, GSI, 2001) (Figure 2). The Deccan basalt lava flows exposed due North of Tapi lineament represents the Satpura Group. The Deccan basalt exposed in the central and northern part, on the other hand Quaternary alluvium is exposed in the southern part of the watershed (DRM, GSI, 2001)

## LINEAMENTS

The lineaments are mappable linear surface characteristics that differ significantly from nearby features and are thought to indicate subterranean phenomena (O’Leary, et al., 1976). According to Edet, et al., (1998) the zones with high degree of rock fractures indicate high lineament density zones, which are favorable for the groundwater occurrence. Satellite photographs are thought to be a superior tool for distinguishing lineaments. Since they are gathered from diverse wave length intervals of the electromagnetic spectrum. (Casas, et. al. 2000). Lineaments are analyzed in order to extract further information about their distribution and characters. The aim of this study is to observe how lineaments are distributed spatially in terms of density, intersection, length and direction to comprehend the Chargarh river basin with

respect to structural setup. The aim of this research is also to study the length and orientation of the lineaments in order to understand the fault system in the area.

***Length of the lineaments***

There are a total 116 lineaments demarcated on the basis of satellite imagery and Arc-GIS 10.2 software, which are having different lengths. There are 89 minor lineaments (< 1.5 km) accounting for 76.72 %and 25 intermediate lineaments accounting for 21.55 %. The minor and intermediate lineaments cover the majority of the study area. Rest of the area comprises only 0.92 % major lineaments (Table 1). The wide range of lineaments with different lengths are given in Figure 2.

**Table 1:** The Major, minor and intermediate lineaments in the WRC-1 Watershed.

| **Sr. No.** | **Category of the lineament** | **Number of lineaments** | **Total Length of the lineaments (Km)** | % |
|---|---|---|---|---|
| **1.** | Major | 2 | 9.914 | 0.92 |
| **2.** | Minor | 89 | 71.802 | 76.72 |
| **3.** | Intermediate | 25 | 54.41 | 21.55 |
| **Total** | | **116** | **136.13** | -- |

***Lineament Trends***

The trends of all the lineaments are (Tables 1 to 4) SSW, NE and SE out of which most common are minor, major and micro lineament trends, where minor lineaments has frequency of 23.59%, 14.60%, 12.35%, 10.11%, 23.59% and 15.73 %; intermediate lineaments has

www.jst.org.in DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182

frequency of 8%, 8%, 16%, 12%, 40% and 16% Whereas, major lineaments having frequency of 50% (Table 2, 3 and 4). Analysis of the lineament trends indicates N-S, ENE-WSW, NE-SW, SE-SW, E-W, as well as ENE-WSW, N-S, NE-SW, E-W, SE-SW are the main directions of regional structures.

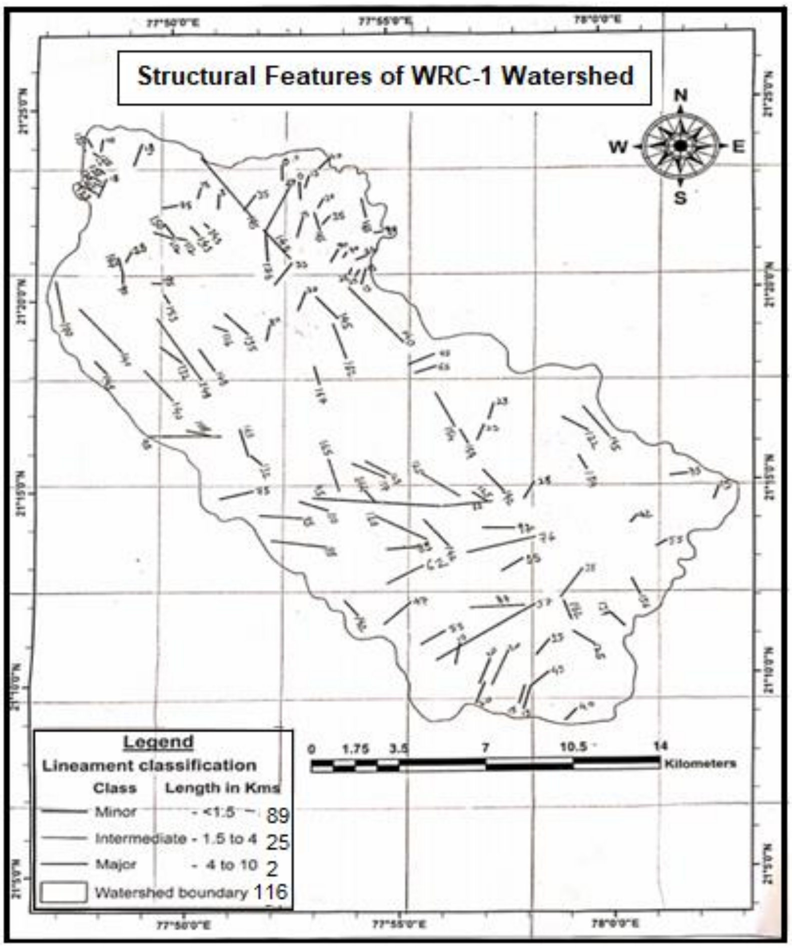


**Figure 2: Lineament map of the WRC-1 watershed.**

**Table 2:** Major lineament trends in the study area.

| Sr. No. | Trends | Number of Fraction | % |
|---|---|---|---|
| 1 | 0-29 | 0 | 0 |
| 2 | 30-59 | 1 | 50 |
| 3 | 60-89 | 0 | 0 |
| 4 | 90-119 | 1 | 50 |

| | | | |
|---|---|---|---|
| 5 | 120-149 | 0 | 0 |
| 6 | 150-179 | 0 | 0 |
| | **Total** | **2** | **100** |
| **Total length** | | **9.91** | |

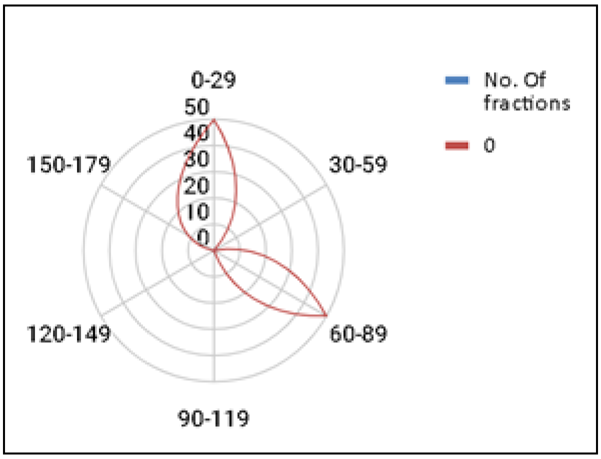


**Figure 3. Major lineament trends in the study area.**

**Table 3:** Intermediate lineament trends in the study area.

| Sr. No. | Trends | Number of Fraction | % |
|---|---|---|---|
| 1 | 0-29 | 2 | 8 |
| 2 | 30-59 | 2 | 8 |
| 3 | 60-89 | 4 | 16 |
| 4 | 90-119 | 3 | 12 |
| 5 | 120-149 | 10 | 40 |
| 6 | 150-179 | 4 | 16 |
| | **Total fractions** | **25** | **100** |

www.jst.org.in DOI: https://doi.org/10.46243/jst.2021.v6.i04.pp172-182

| | | |
|---|---|---|
| **Total length** | **54.41** | |

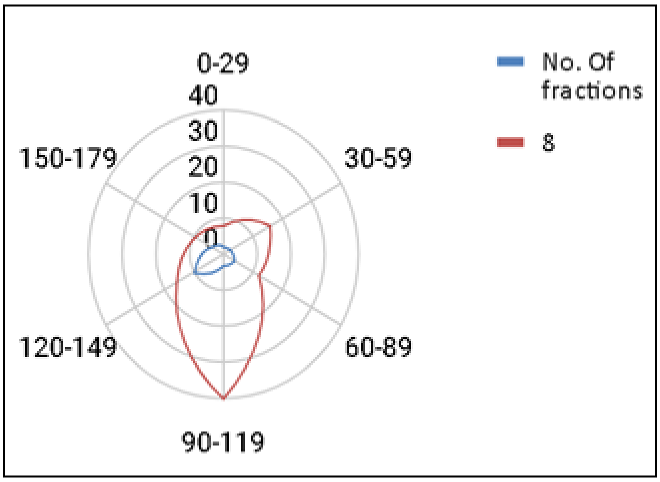


**Figure 4: Intermediate lineament trends in the study area.**

**Table 3:** Minor lineament trends in the study area.

| Sr. No | Trends | Number of Fraction | % |
|---|---|---|---|
| 1 | 0-29 | 21 | 23.59 |
| 2 | 30-59 | 13 | 14.60 |
| 3 | 60-89 | 11 | 12.35 |
| 4 | 90-119 | 9 | 10.11 |
| 5 | 120-149 | 21 | 23.59 |
| 6 | 150-179 | 14 | 15.73 |
| | Total fractions | **89** | **100** |
| **Total length** | | **71.80** | |

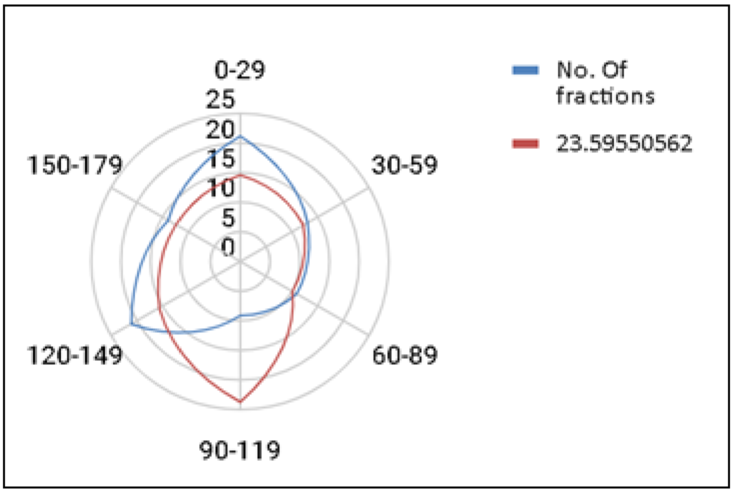


**Figure 5: Minor lineament trends in the study area.**

**CONCLUSIONS:**

During this study remote sensing and GIS techniques are successfully utilized to identify the lineaments and their mapping with the help of satellite data. The WRC-1 watershed is a part of the well-known orange orchard belt of central India. In this area depletion in static water levels of the unconfined aquifer resulted due to high groundwater withdrawal for orange cultivation. Thus,the area requires rapid sustainable water and artificial recharge solutions for water resource management. The area examined for lineament/fracture analysis reveals that there are several long and short lineaments, with the structural trends mostly due North-East and South-West. The cross-cutting lineaments are rather high in the area, especially in the central, North-eastern, and South-western regions, but relatively low in other parts of the watershed. The tectonic activity in the area is represented by the density of lineament intersections. The total 116 lineaments with a total length of 136.13 kilometers were measured from the satellite image (Table 1). Intermediate lineament has length of 54.41 km, minor lineament has length of 71.80 km and major lineament has a length of 9.91 km. The lineament density is high in the Central, North-eastern, and South-western regions. It is observed that the zones with high degree of rock fractures are favorable for the groundwater occurrence. The general frequency of the lineament trends throughout the area are North-East and South-West. The E-W, SE-SW, NE-SW, ENE-WSW, N-S axes are also the principal orientations of regional structures, especially for the major inclinations of the lineaments in the area. The lineaments of the area are linked with the major faults, as well as the linear features intersecting and cross cutting the geological structures. The lineaments of the area are also useful to identify deep seated faults, which are suitable for groundwater occurrence.

**REFERENCES:**

Acharyya, S.K., Kayal, J.R., Roy, A. and Chaturvedi, R.K. (1998) Jabalpur earthquake of 22 May 1997: Constraint from after shock study, Jour. Geol. Soc. Ind., vol. 51, pp.295-304.

Auden, J.B. (1949) Geological discussion of the Satpura hypothesis., Proc. Vol. of the Nat. Inst. Sci. India, vol.15, pp.315–340.

Casas, A. M.; Cortes, Angel, L.; Maestro, A;, Soriano, M.A.; Riaguas, A. and Bernal, J., (2000) A program for lineament length and density analysis, Computers and Geosciences, vol. 26, No. 9 &10, pp. 1011-1022.

Chattopadhyay, A., Khasdeo, L., Holdsworth, R.E. And Smith, S.A.F. (2008) Fault reactivation and pseudo-tachylyte generation in the semi-brittle and brittle regimes:Examples from Gawilgarh–Tan shear zone, Central India, Geol. Mag., vol.145(6), pp.766-777.

Fuladi A.D. and Deshmukh M.S.(2020)Remote Sensing and GIS Approach to the Morpho-geological Characteristics of WRC- 1 Watershed, Chargarh River Basin, Central India, Jour. Ind. Geol. Cong.,vol.12 (1), pp. 31-39.GSI, DRM (2001) District resource map of Amravati district, Maharashtra, Geol. Survy. of Ind. publ., Central Region, Nagpur, Maharashtra, India.

Kamiński, Mirosław, (2020) DTM-based analysis of the spatial distribution of topo-lineaments, Open Geosciences,vol.12, No.1,pp. 1185-1199.

Lillesand, T.M. and Kiffer, R.W. (1994). Remote sensing and image interpretation, 3rd edition, John Wiley and Sons, New York, USA,750p.

Manjare B.S. (2013) Mapping of Lineaments in Some Part of Betul District, Madhya Pradesh and Amravati District of Maharashtra, Central India, Using Remote Sensing and GIS Techniques, Inter. Jour. of Adv. Rem. Sen. and GIS, vol. 2(1), pp.331-340.

Manjare, B.S. (2017) Drainage characteristics of tectonically active areas in Wardha and Purna river basin, Central India using satellite data, Journal of Geomatics, vol.11, No.2, pp.260-267.

Nalbant,S., and Alptekin,O.(1995) The use of Landsat Mapper imagery for analysing lithology and structure of Korucu-Dugla area in western Turkey, Inter. Jour. of Rem. Sens.,vol.16, No.13, pp. 2357-2374.

O'Leary, D. W.; Friedman, J. D. and Pohn, H. A.(1976) Lineament, linear, lineation:Some proposed new standards for old terms,Geol. Soc. of Ameri. Bull., vol.87,pp.1463-1469.

Rajurkar,S.T. (1981). Photographic Interpretation of Upper Wardha Project and Surrounding Area, Wardha, Amravati and Betul Districts., Geol Suvy. of Ind., pp. 69-292.

Rajurkar, S.T.(1992) Photographic interpretation of Upper Wardha project and surrounding area of Wardha ,Amravati and Betul districts, Golden Jubil. Sympo. vol. Department of Geology, Nagpur University, Nagpur (M.S.), India, pp.269-292.

Ravi Shanker (1994) Geothermal Regime of the Son–Narmada–Tapti Lineament Zone, Geol. Survy of Ind., Spl. vol.10, pp. 213–248.

Sabins, F.F. (2000)Remote Sensing: Principles and Interpretation, Freeman publ., New York, USA,494 p.

Saxena, R. K.(1994) Geothermal Investigation around Salbardi Hot Spring Area, Dist. Betul (M.P) and Amravati Maharashtra, Geol. Survy. of Ind., pp.1981-82.

Tiwari, M. P.(1985) Neo-tectonism in Tapti Purna Valleys and its Probable Correlation with Geothermal Activity(Geothermal Energy of India), Geol. Survy. of Ind., Spl. vol.45; pp.325-332.