INTERPRETATION OF LITHOLOGICAL UNITS AND STRUCTURAL LINEAMENT USING GEOSPATIAL TECHNOLOGY- A CASE STUDY OF BHOPAL, M.P., INDIA

Shraddha Shrivastava, *Vineesha Singh, ** H. U. Usmani
Research Scholar, Barkatullah University Bhopal; *Deptt. of Earth Sciences, Barkatullah University, Bhopal; **Deptt. of Geology, Govt. Motilal Vigyan Mahavidyalaya, Bhopal

Abstract

A short approach for establishing a correlation between lineaments and geological features is made in the current study using geospatial technology and remote sensing satellite images. The study area located in Bhopal District and geographically lies between latitude 23°05′ to 23°30′ North and longitude 77°15′ to 77°30′ East covering an area of approximately 712 sq. km. LISS III Satellite image obtained from ISRO is used for interpretation of geological features and lineaments present in the study area. Results show that the satellite image with 23.5m resolution and geospatial technology proves to an important tool for mapping and analysis of earth phenomenon. Most of the lineaments found on edges of two different lithological units present in the study area.

Key words: Lineaments, Lithological units, Remote Sensing, Geographical Information System (GIS).

I. Introduction

All phenomenon on the earth are correlated with each other like morphology of earth depends on lithology and tectonic activities. Lineaments are the major impression on earth which reveals sub sequential activities and geological setup of the earth. Accurate geological features mapping is a critical task for oil exploration, groundwater storage and understanding the mechanisms of environmental disasters, for instance, earthquake, flood and landslides (Marghany et al., 2010). Lineament interpretation and extraction from remote sensing satellite image has been performed by several researchers over the world for many purposes, for instance, structural and tectonic analysis (Won et al., 1997; Kim et al., 1999; Madani, 2001; Sedrettea and Rebaïb, 2016; Si Mhamdi et al., 2017). Lineaments are mainly controlled by two major activities, one is geomorphic activities and other is structurally controlled. Remote sensing and GIS technology proved to be an efficient way to be interpreted and extracted as lineaments. LISS-III satellite image with resolution of 23.5m resolution are very useful for the same.

II. Study Area

Present Study area lies between latitude 23°05′ to 23°30′ North and longitude 77°15′ to 77°30′ East covering an area of approximately 712 sq. km. administratively it covers under Bhopal district of Madhya Pradesh state and surrounded by other districts viz. Guna district on the north, Vidisha district on the northeast, Raisen district on the east, Sehore and Rajgarh districts on the southwest and west respectively. As per Survey of India, this area covers in topographic sheet no 55E/7 and 55 E/8. Study area map is shown in Fig. 1.

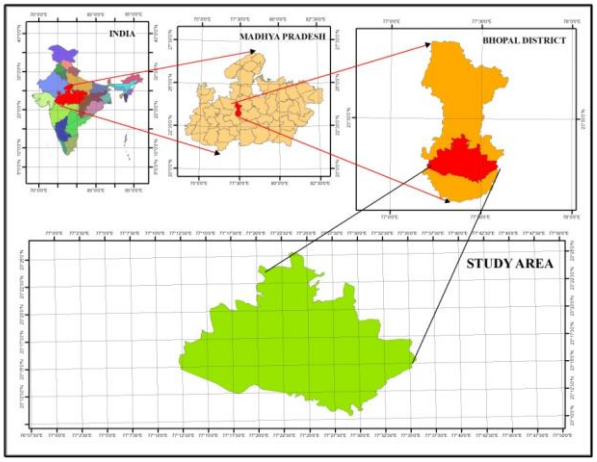

Figure No. 1 Location map of the study area

III. Material used

Satellite images of LISS III Sensor (IRS satellite) launched by ISRO is used for interpretation of geological features and lineaments. Satellite image is downloaded from BHUVAN portal of the ISRO. Geographical reference is taken from Survey of India

topographic sheets, which are on 1:50000 scale. The major part of the study area is covered in toposheet no 55 E/7 and 55 E/8.

Table No. 1 Specification of LISS III Sensor

S.No.	Parameter	Specification
01	Orbital Altitude	817 km
02	Spatial resolution	23.5 m
03	No. of bands	04
04	Swath	142 km at nadir

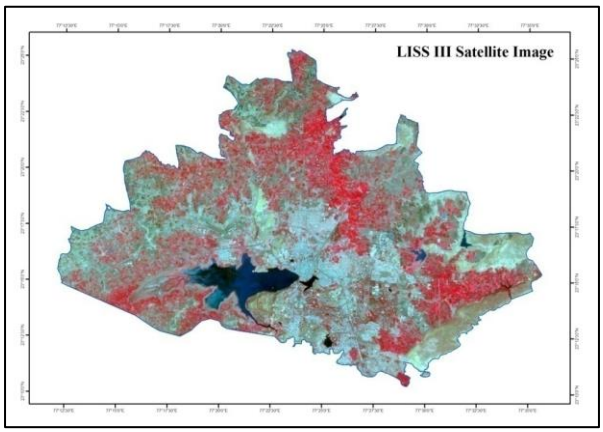

Figure No. 2 Satellite Image of the Study Area.

District resource map (DRM) prepared by Geological Survey of India for Bhopal District is also used for reference and accuracy of the research. DRM of the district reveals major geological setup of the district along with major phenomenon present on the concern district. Computer hardware with RS and GIS based software is the essential requirement of the study. ERDAS IMAGINE and Global Mapper are using for the image registration, rectification, image processing (IP) and enhancement of satellite imagery. ArcGIS is using for vectorization, thematic mapping, topological error correction and map generation. Grapher is using for the generation of graphs based on tabular data and results. Microsoft Office is used for the documentation, data tabulation and presentation preparation the computing platform. Global positioning system (GPS) is used during field survey.

Methodology Adopted

A brief methodology is adopted for interpretation of lineament and other geological features present in the study area. In first step, satellite image of the study area is downloaded from BHUVAN portal of ISRO, Govt. of India. The image is enhanced using ERDAS Imagine software, various image enhancement techniques were applied for better visualization of images. Satellite image were rectified using ground control points marked on survey of India topographic sheets. Lineament mapping were done on the basis of keys of image interpretation like tone, texture, pattern, shape, size etc. geological mapping is done with the help of DRM of Bhopal District. Geomorphological map is prepared using satellite image of the study area. Brief methodology is shown in Fig. 3.

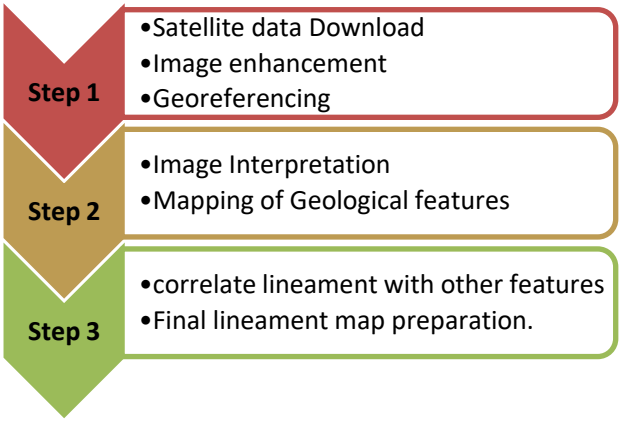

Figure No. 3 Brief Methodology adopted for research.

Geological setup of the study area

The area of present study is almost the north western part of Bhopal district. The rocks exposed in the area include the Vindhyan sediments and basaltic lava flows of Deccan Trap activity. The geological succession of the litho units found in the present area is given in the Table 2 and the geological map of the study area prepared using remotely sensed data and DRM (2002) (GSI) and is presented in Fig. 4. The main rock formations exposed in the present study area embrace the Upper Rewa sandstone, Lower and Upper Bhander rocks. This sedimentary sequence is dominantly arenaceous with subordinate argillaceous rocks, the arenaceous rocks are sandstones.

Table 2 Geological Succession of the Study Area

Lithology	Group	Age	Nature and characteristic
Upper Bhander Sandstone		V I N D	Pink, maroon pink and chocolate brown, fine to

	BHANDER GROUP	HYA UPPERN PROTEROZOIC SUPERGROUP	coarse grained, hard rock
Sirbu shale			Yellow, greenish and chocolate brown, thinly laminated, fine grained, soft rock
Lower Bhander Sandstone			Pink, pinkish brown, dark red, chocolate brown fine to coarse grained, thickly bedded, hard massive rock
Upper Rewa Sandstone	REWA GROUP		White, greyish white, pink and pinkish white medium to coarse grained, thinly bedded and flaggy hard rock.

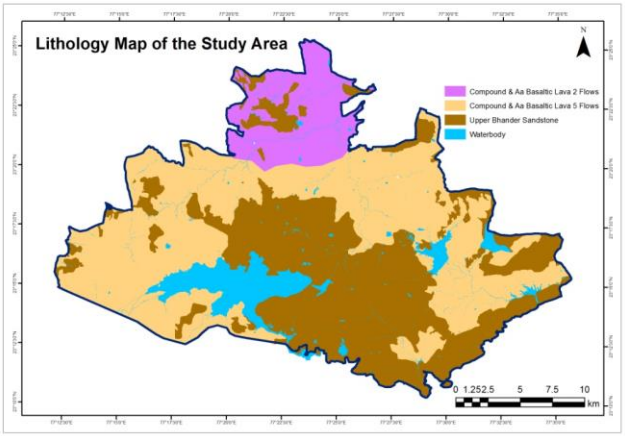

Figure No. 4 Lithology Map of Study Area

Lineament Mapping of the study area

Lineament map of the study area reveals that major lineaments are present in the northern direction of the study area. The existence of feature shows east – west direction. Most of the lineaments are present along drains present in the study area. The smallest lineament mapped in the study area is of 129 meter length and longest lineament mapped is of 4367 meter in length. Detail length of the lineaments is shown in Table 4 and lineament map is shown in Fig. 5.

Table 3 Lineament details of the Study Area

S,No.	Lineament	Total Length (in meter)	Total Number of Lineaments
1	Major Lineaments	43519.68	15
2	Minor Lineaments	18623.84	14

Table 4 Lineaments inventory of the Study Area

S. No.	Length Range	Number of Lineaments
1.	<1 km	3
2.	1-2 km	12
3.	2-3km	8
4.	3-4km	6
5.	>4km	1
6.	Grand Total	30

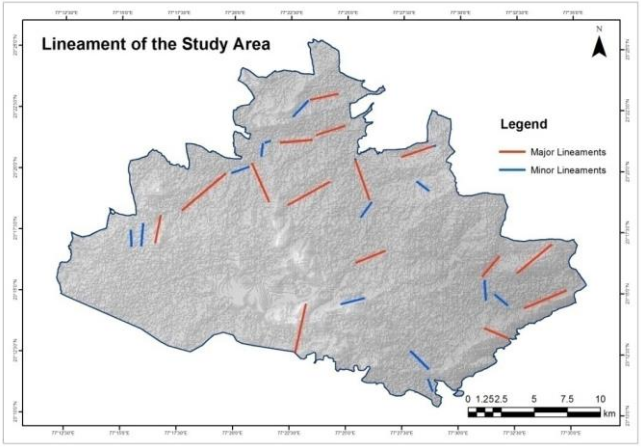

Fig. 5 Lineament map of the Study Area.

IV. Result and Discussion

Correlation of lineaments interpreted from remote sensing satellites and geological features are shown in Fig. 5. The interpretation shows that lineament no 3,6,12, 15, 16, 17 and 21 are present at the edge of two lithological units. There are two major litho units present in the study area, one is basalt and other is sandstone. Remote sensing satellites prove to be an important tool for mapping and interpretation of geological features as well as in identification of lineaments in the study area. According to Table 4 we

find that the 3 lineaments are less than 1 km, 12 lineaments are 1-2 km, 8 lineaments are 2-3 km, 6 lineaments are 3-4 km. and greater than 4 km is only 1 lineament present in study area.

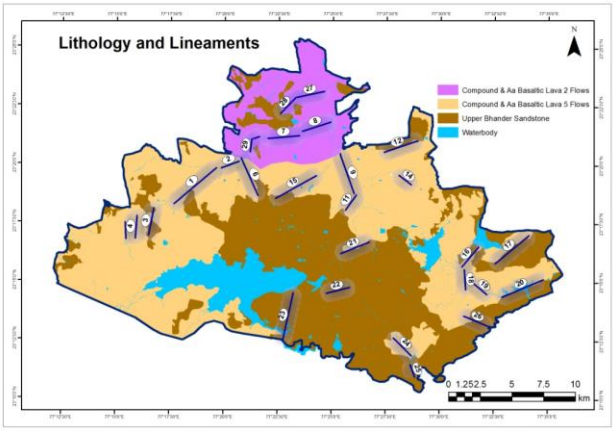

Fig. 6 Correlation of Lithology and Lineaments

Conclusion

Remote sensing satellite provides a synoptic view of the terrain and its capability to visualize in different spatial resolution is important and very useful in mapping and identification of earth phenomenon. In the current study area, mapping and analysis of lineaments along with geological features show that most of the lineaments are found in basaltic terrain and at the union point of two different lithological units. The inferences obtain from the study may be used for many studies related to tectonic activities.

References

[1] Sedrettea, S. and Rebaïb, N. (2016) Automatic extraction of lineaments from Landsat Etm+ images and their structural interpretation: Case Study in Nefza region (North West of Tunisia). J Res Environ Earth Sci v.4, p.139- 145.

[2] Si Mhamdi, H., Raji, M., Maimouni, S., and Oukassou, M. (2017) Fractures network mapping using remote sensing in the Paleozoic massif of Tichka (Western High Atlas, Morocco). Arab J Geosci v.10: https://doi.org/10.1007/ s12517-017-2912-5.

[3] Madani, A. A. (2001) Selection of the optimum Landsat Thematic Mapper bands for automatic lineaments extraction, Wadi Natash area, South Eastern Desert, Egypt. 6

[4] Maged Marghany* and Mazlan Hashim, 4 September, 2010, Lineament mapping using multispectral remote sensing satellite data, International Journal of the Physical Sciences Vol. 5(10), pp. 1501-1507.

[5] Chaabouni, R., Bouziz, S., Peresson, H., and Wolfgang, J., 2012 Lineament analysis of south Jenein Area (Southern Tunisia) using remote sensing data and geographic information system Vol. 15. Issue 2, pp. 197-206.

[6] Ramli, M. F., Yusuf, N., Yusoff M. K., Juahir, H., and Shafri, H. Z. M. 2010 Lineament mapping and its application in land slide hazard assessment: a review Bull Eng. Geol Evviron 69:215-233.

[7] Chunzhong Ni., Zhang S., Yongfeng, L., Liu, C., and Li, Y., 2016 Lineament Length and Density Analysis Based on the Segment Tacing Algorithm: A case study of the Geosorg Field in Gejiu Tin Mine, China Research Article Hindawi Publishing Corporation.

[8] Fajri, S. N., Surtiyono, E., and Nalendra, S., 2019 IOP Conf. Series:Materials Science and Engineering 636, 012001.