Geological mapping for Thandava Reservoir Catchment of Visakhapatnam, Andhra Pradesh using Geo-Spatial technologies

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Abstract- A geologic map provides basic data for understanding both past and present-day processes affecting a region of the Earth. This is the key to provide geologic information that can be utilized to reduce death and damage caused by geologic hazards. For the present investigation, thematic maps of geology have been generated from the IRS-ID-LISS III, dated on 11th Jan 2011. Standard visual interpretation methods given by NRSA (1996) have been adopted to portray the features on map. From this study of the Thandava reservoir, the result of geology map shows that most of the area is occupied by migmatite (67%) followed by Khondalite (20%). Further, the results of lineament map showed the main strike directions were associated with two trending NW–SE and NE–SE. This reveals that the area had been structurally controlled. These structural features have played a prominent role in relation to drainage development and erosion in the area.

Keywords: geologic map, geologic hazards, lineament map, strike directions.

1. INTRODUCTION

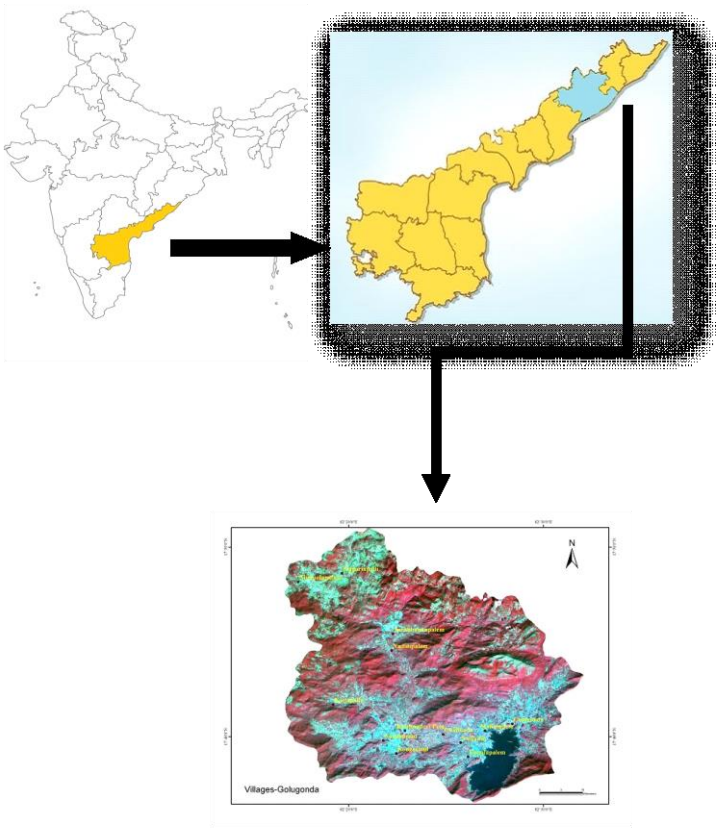
A geology map is a special-purpose map made to show geological features. They are depicted by color or symbols to indicate where they are exposed at the surface. All the structural features such as faults, folds, foliations, and lineaments are shown with strike and dip or trend and plunge symbols which give them the 3D orientations. The strike of the rock formations is NNE-SSW; however, local variations are observed (Sriramadas, 1964; Chetty *et al*, 2002; Jagadeeswara Rao, 2006). A lineament is a linear feature formed at fracture zones, shear zones and igneous intrusions such as dykes that emphasizes an underlying geological structure. It may comprise of fault-aligned valley, a series of faults or fold-aligned hills, a straight coastline or indeed a combination of these features. Thery are often apparent in geological or topographic maps and are clearly visible on aerial photographs or as linear tonal discontinuities in satellite images. Various scientists have emphasized the importance of aerial photos and satellite imagery in structural analysis, especially in lineament mapping (Prudhvi Raju and Vaidyanadhan, 1981).

Lineaments with criss-cross nature generally show very high groundwater potential. If these lineaments are fed by any river system and extend down to plain lands, they are potentially exploitable (Sanjay Raj and Sinha, 1989).

The overall trend of these lineaments reveals that the area had been structurally controlled. There are structural hills and structural valleys observed at places. There is innumerable number of secondary intrusions occurring as ridges at places. These structural features have played a prominent role in relation to drainage development and erosion in the area. The study area is surrounded by high hill ranges such as Bointi reserved forest, Dharakonda reserved forest, Sarugudu reserved forest, and Karaka reserved forest. The khondalite rocks are whitish to brick red and are easily susceptible to weathering whereas the charnockite rocks are characterized by their intrusive relationship with the host khondalite suite of rocks. Compositionally, the charnockites exhibit acidic to basic. The Quartzite is hard, highly fragmented and fractured.

2. STUDY AREA

The study area is located in the hilly terrain of the Eastern Ghats region of Visakhapatnam district, Andhra Pradesh with catchment area of 467 km² and is constructed with the gross storage capacity of 4960Mcft. It is a chief category in non-perennial rivers with only one tributary named Bodderu (Thandava Nadi). The reservoir is located between 17°45’50” North latitude and 82°15’20” East longitude (Figure1). It is covered in the survey of India toposheets 65 K/5, 65K/6, 65K/9, 65K/10 on 1:50,000 scale and IRS-1D-LISS-III digital data of 2011 have been used for extraction of thematic information on geology. The Thandava Reservoir Catchment (TRC) is characterized by undulating topography, with hill ranges (320m-540m above M.S.L) on Northern, Southern and Western sides, and Bay of Bengal on the eastern side. It is composed of high-grade metamorphic rocks and igneous rocks. The study area geologically belongs to Precambrian age.



(Study area as viewed on IRS-ID-LISS III, dated on 11th Jan 2011)

Figure 1: Location map of the Thandava Reservoir catchment

3. METHODOLOGY

The base map of the study area is prepared from the Survey of India (SOI) topographic maps numbered 65 K/5, 65K/6, 65K/9, 65K/10 on 1:50,000 scale. The geology map of the area has been taken from the district Geology and Mineral resource map-2001, published by Geological Survey of India (GSI). The methodology carried out for further processes are provided in Figure 2. Later, the lineament map has been generated on toposheets and cross checked with the satellite imagery, considering the major drainage as a surface control (Figure 3).

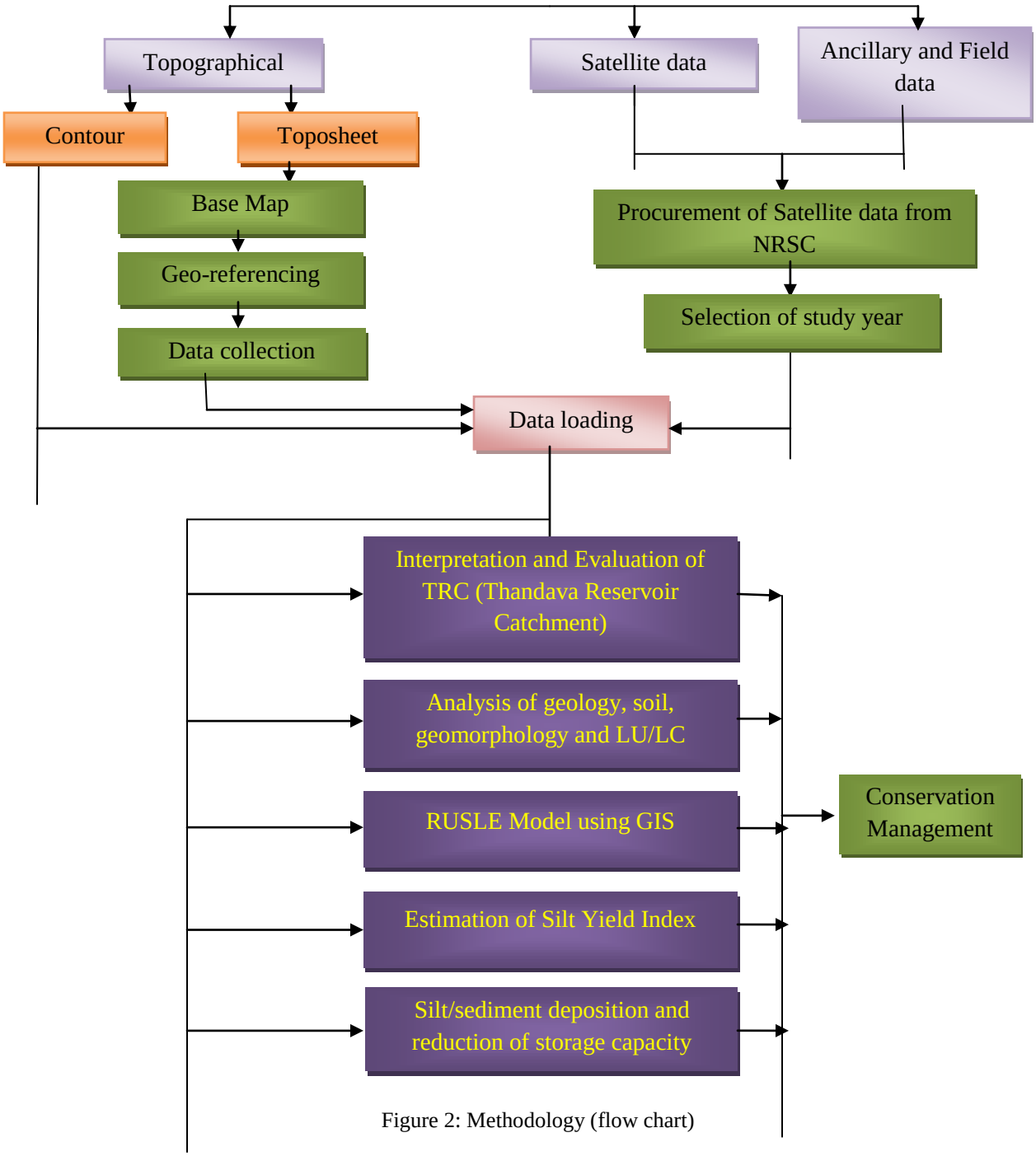


Figure 2: Methodology (flow chart)

4. RESULTS AND DISCUSSIONS

Lineament mapping depends on visual perception and the ability to recognize patterns in the imageries. Major lineaments are delineated in faults and fractures as confirmed lineaments whereas minor drainages occupied in joints, shear zones, etc. have been delineated as inferred lineaments.

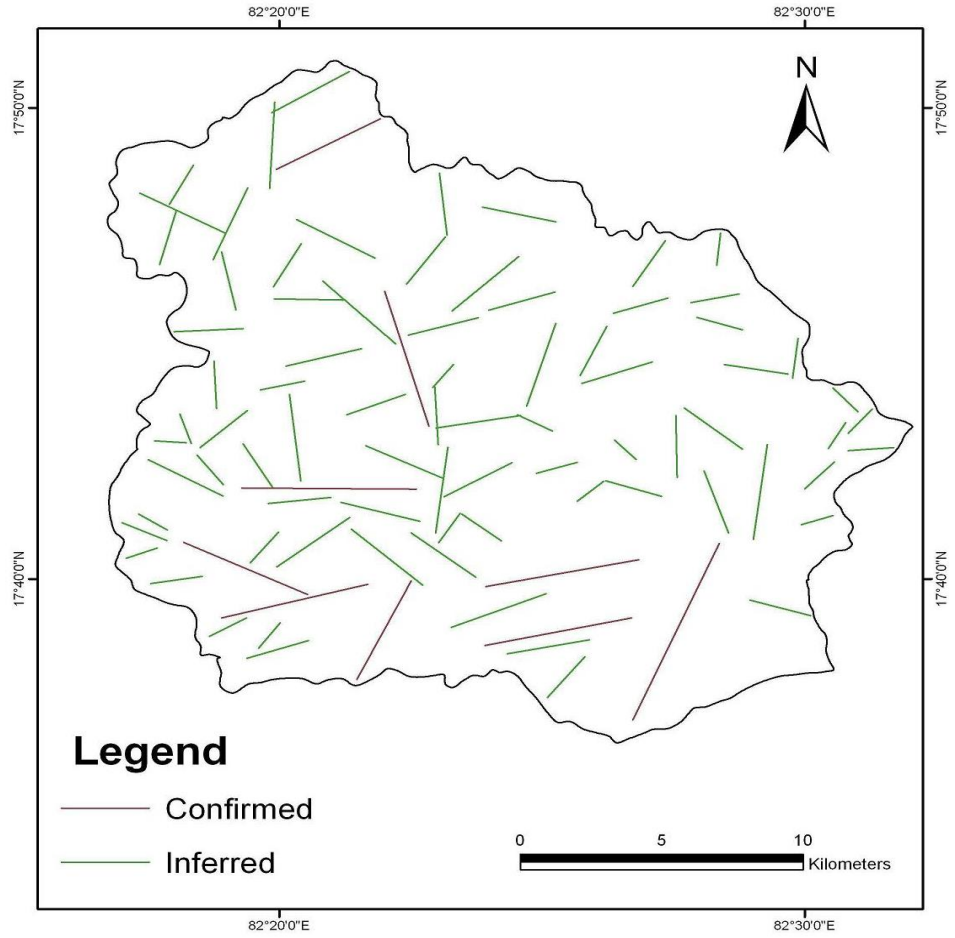


Figure 3: Lineament map of the study area

About 87% of the study area is occupied by Migmatite group of rocks. Charnockites can be called as hypersthene bearing granite and mainly occur as two types. They are hypersthene bearing granitic rocks and porphyritic ferro hypersthene granodiorites. (Figures 4, 5 and Table 1)

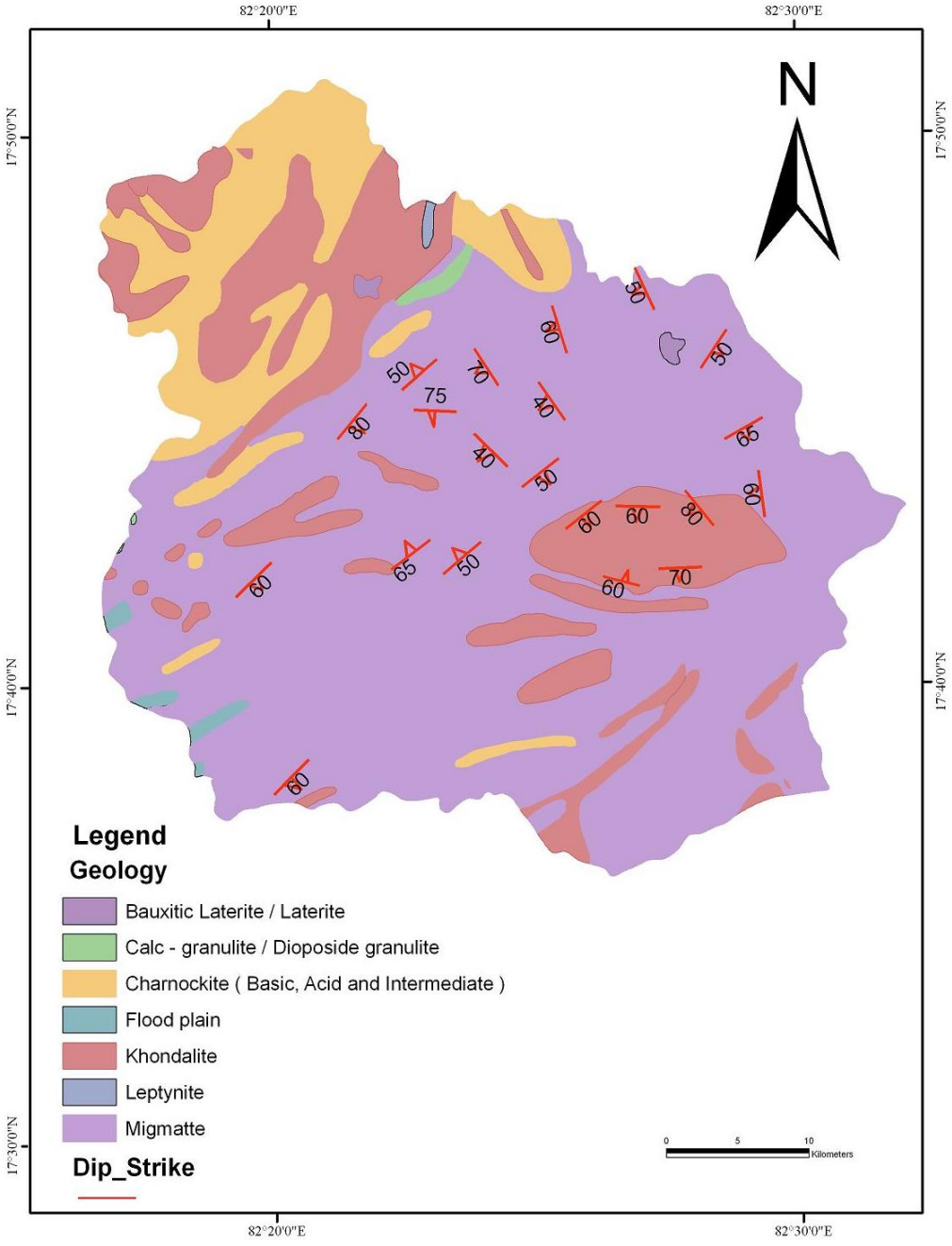


Figure 4: Geology map

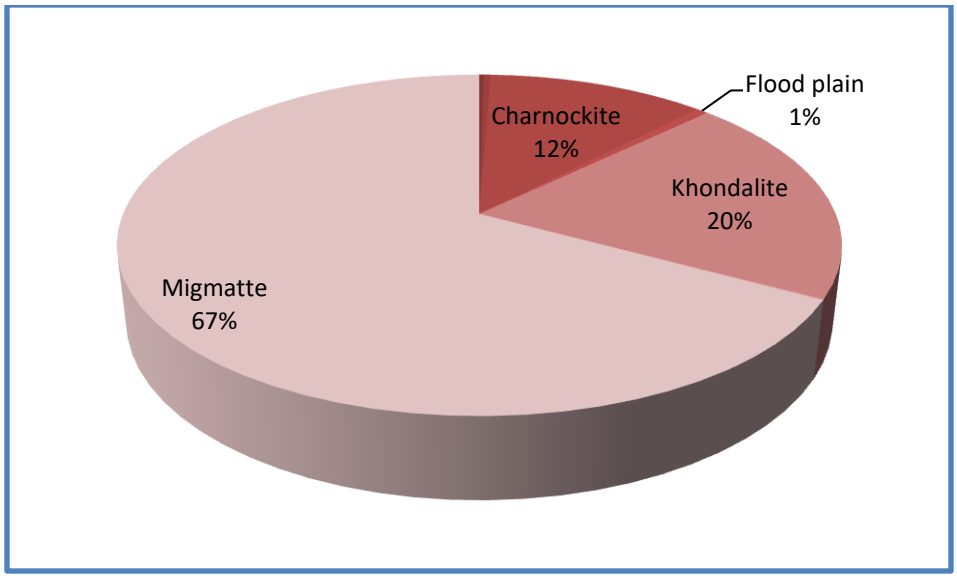


Figure 5: Percentile distribution of Geological features

Table 1. Area under different rock types

Geology type	Area in km^2
Charnockite	54.39
Flood Plain	3.12
Khondalite	93.59
Leptynite	0.495
Migmatite	314.38
Bauxitic Laterite / Laterite	1.16
Calc-granulite/Dioposide granulite	1.69

a) Khondalite:

Khondalite is a foliated metamorphic type of rock composed of garnet, sillimanite, graphite and feldspar. They have also been variously called Bezawada gneiss, Kailasa gneiss, etc. They have been derived from high alumina clays which were also rich in iron. Some varieties rich in feldspar (in some cases feldspar occurs as phenocrysts too). On weathering, these rocks give raise to laterite and bauxite. The high grade metamorphism seen in khondalites is also an indication of the tectonic activity. Khondalites occupy nearly 93.59 km^2 of the study area. Some of the places are Jodumulu, Singadhar, Chidikada, Limgampeta, Gaurammapeta etc.

b) Calc-Granite gneiss:

Granite gneiss, also known as diatexite, is the frontier between igneous and metamorphic rocks. They are formed under extreme temperature conditions during pro-grade metamorphism, where partial melting occurs in pre-existing rock. They occur within extremely deformed rocks typically within Precambrian cratonic blocks. In many cases, the darker part of the rock, consisting of biotite mica and hornblende, has been intruded by veins of lighter part consisting of quartz and feldspar. Granite gneiss is occupied about 1.69 $km^2$of the study area. Some of the areas are Bointi Reserved Forest, some of the Dharakonda Reserved Forest.

c) Flood Plain:

A floodplain is a nearly flat land adjacent to a river steam that stretches from the banks of its channel to the base of the enclosing valley walls and experiences inundation during periods of high discharge. They are made by a meander eroding sideways as it travels downstream. When a river breaks its banks and floods, it leaves behind layers of rock and mud. These gradually build up to create the floor of the flood plain. They generally contain unconsolidated sediments: sand, gravel, loam, silt, and/or clay that often extend below the bed of the stream. These are often important aquifers, the water drawn from them being pre-filtered compared to the water in the stream. Floodplain occupied nearly 3.12 km^2 of the study area.

d) Charnockite:

The charnockite is one of the kinds of igneous rocks that are metamorphosed and are rich in hypersthene and microcline. Charnockites are occurring in the upper part of the study areas that cover 54.39 km^2. Some of the areas are Singarapalli, Modyam, Lingavaram, Rampulu, Kummarapalli.

e) Laterite:

Laterites are rich in iron and aluminum, formed in hot and wet tropical areas and appear rusty-red because of iron oxides. They develop by intensive and long-lasting weathering of the underlying parent rock. Laterites are in the vanity of Bointi Reserved Forest.

f) Migmatite:

Migmatite occupy 314.38 $km^2$of the study area abundantly however some pocket areas have shown different rock formation. Some of the areas are occupied by Sodyam, Golugonda, Krishna Devi Peta, Nagapuram, Kongasingi, Pallavuru, etc.

g) Leptynite:

The leptynites with medium-grained and light cream to grey in colour are easily weathered. Generally, they support the occurrence of groundwater, but their spatial coverage is limited. The area covered by leptynite is 0.495 km^2. Saramanda area is occupied by Leptynite.

5. CONCLUSION

The study area reveals that using Remote Sensing and GIS techniques are highly beneficial in identifying geology of an area. From this study, the result of lineament map of the Thandava reservoir showed different lineament strike directions as the following: EW–NE, WE-NS and NS as a main lineament direction and these strike directions were mainly associated with NW–SE and NE–SE. The Thandava reservoir area is composed of high-grade metamorphic rocks and igneous intrusive rocks. Most of the area is occupied by migmatite (67%) followed by Khondalite (20%), charnockite (12%) and sparse amounts of quartzite, granite gneiss, laterites, leptynite, etc. The general trend of strike is NE-SW through E-W to NW-SE with a dip of 70-80° SE. These structural features have played a prominent role in relation to drainage development and erosion in the area.

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