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Structural Control On The Drainage Of Ravines In The Lower Chambal Valley, Manifests Neotectonic Reactivation Of The Old Underlying Structural Elements

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Abstract
The Lower Chambal Valley (LCV) is a low-lying fluvial landscape and draining lower reach of the river Chambal. The southern part of the area has a thin layer of sediment that covers the Vindhyans Super Group of Rocks, while the northern part has a thick layer of sediment that makes up the western part of the Marginal Gangetic Alluvial Plain (MGAP). This area may also be underlined by Bundelkhand Granite. The study area has several unusual landforms, such as deep river valleys, extensive ravines, old river channels, and irregular drainage patterns. These features are believed to be related to neotectonic activities. Thanks to the advancements in Remote Sensing and GIS technologies, it is now easier to study these large landscapes.
In this study, we aim to use CartoDEM data and QGIS software to trace the lineaments that influence the drainage pattern of ravines and the mainstream. Additionally, we will examine how these lineaments relate to the underlying rock structures of the Vindhyans and Bundelkhand Granites.
Keywords: *Lower Chambal Valley, Ravines, Structures, Carto-DEM, QGIS.*

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I. Introduction

The Quaternary geological landscapes have the ability to preserve important geological, tectonic, and climatic changes. Alluviums from in this period can serve as a sort of museum showcasing recent changes, including Neotectonic signatures that are easily distinguishable in fluvial landscapes. These changes can be seen through the evolution and formation of landforms, relief features, and drainage features. The Lower Chambal Valley (LCV) is a low-lying region located downstream of the Chambal sub-basin of the Ganga Basin (as shown in Figure 1) (**(Ahmad (1968, 73), Sharma (1968, 79, 80) and Ranga (2015**)). The study area spans across three states in India, including Guna, Sheopur, Morena, and Bhind districts of Madhya Pradesh; Baran, Kota, Jhalawar, Bundi, Sawai Mdhopur, Karauli, and Dholpur districts of Rajasthan; and Agra and Etawah districts of Uttar Pradesh. Geographically, the study area is bounded by Latitude 24˚30' N - 27˚00'N and longitude 75˚30' E-79˚30'E. It covers a total area of 28060 square kilometres and falls on Survey of India Degree sheet numbers 46N, 46M, and 45P. The river flows on alluvium, which was deposited by the Chambal River itself. The valley itself is triangular in shape and points towards the northeast while being surrounded by linear belts of the Vindhyans System of Rocks on three sides. The area is primarily drained by the Chambal River and its tributaries, including Kalisindh, Parbati, and Kuno. Due to the differences in physiography within the valley, it can be divided into two parts: The Southern Lower Chambal Valley (SLCV) and the Northern Lower Chambal Valley (NLCV). The SLCV is the southern triangular part of the valley, covered by thin alluvium and underlined by the Vindhyan Supergroup of Rocks. It is drained by the Chambal River and its tributaries Kalisindh and Parvati. The NLCV is the curvilinear extreme downstream part of the valley, covered by thick Western Marginal Gangetic Alluvium and drained mainly by the Chambal River. It also has an extensive ravine land zone (Chambal Beehad) around the incised valley.

Geologically, the Lower Chambal Valley is located between two types of Vindhyan rocks with different strikes. On the southeastern side of the valley, there are curvilinear strike rocks that resemble the periphery of the Bundelkhand Granitic Massif. On the northwestern side, there are rocks with a strike parallel to the Great Boundary Thrust. The southwestern side of the valley is bounded by the Vindhyan Hills of the Mukundwara Fault. The valley is covered by a thin layer of alluvial soil and rocks of the Vindhyan system in the Southern Lower Chambal Valley (Heron 1922, Saxena 1975). Meanwhile, the Northern Lower Chambal Valley has thick older alluvium of the Western-Marginal Gangetic Alluvial Plain (Agrawal,2001, Bilham,2003, Mishra & Vishwakarma, 1999) The eastern side of the LCV features the exposure of the Bundelkhand Granitic Massif, which serves as the valley's basement.

Structurally, in the Lower Chambal Valley (LCV), the Vindhyan rocks on the eastern boundary exhibit a dip towards the northwest direction with a curvilinear strike that resembles the periphery of the Bundelkhand Massif, forming a hogback topography. Major structural features in the LCV include the Great Boundary Thrust, Mukundwara Fault, Chambal Thrust, Parbati Fault, Ramgarh Crater, and other anticlines in the Southern Lower Chambal Valley (SLCV), as shown in Figure 6 (Bhoj et al, 2012). The SLCV lies over the footwall of the Mukundwara Fault and has low relief. The Chambal River in the LCV flows along the Chambal Thrust, while the Parvati River flows along the Parvati Fault. Previous researchers have also identified anticlines in the area.

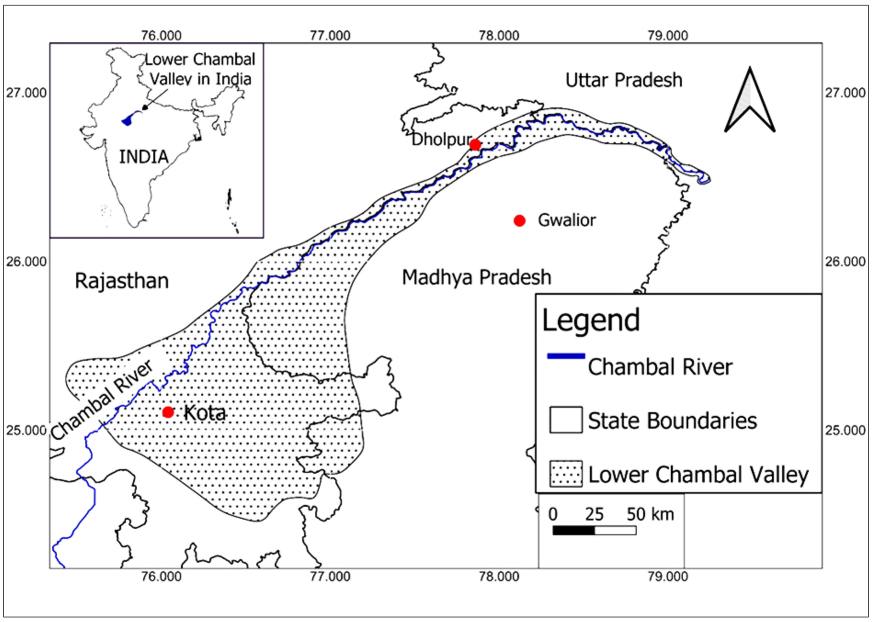


Fig.1. Location Map of the Study Area

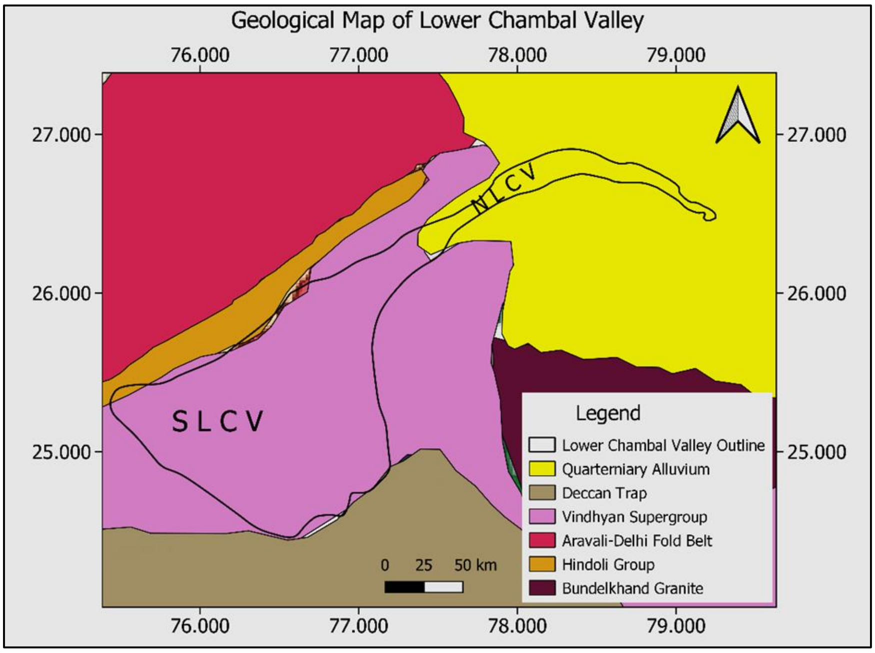
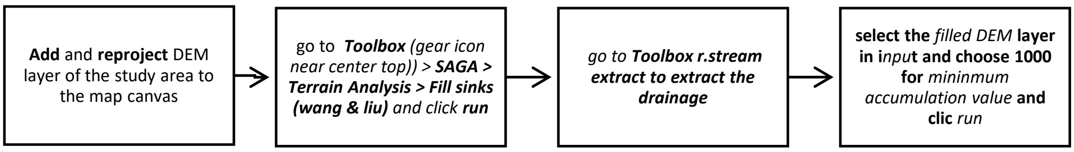


Fig.2. Geological Map of the Lower Chambal Valley (modified after Roy and Jakhar 2002), SLCV= Southern Lower Chambal Valley, NLCV= Northern Lower Chambal Valley

II. Materials and Methods:

The study utilized Remote Sensing Data and GIS tools, specifically CartoDEM and QGIS Desktop version 3.30.3, to create several maps. The following section provides a brief explanation of the data sources and procedures used.

1. **Data Collection**- I obtained Toposheets (Open Series Map) with a 1:50,000 scale from Survey of India through https://onlinemaps.surveyofindia.gov.in. To conduct terrain analysis, I also downloaded the Digital Elevation Model (DEM) of the study area from https://bhuvan.nrsc.gov.in/, which is available with a 30 M spatial resolution.
2. **QGIS work:** Several initial tasks were carried out before extracting the drainage, including acquiring and importing data to QGIS, merging raw DEM tiles, projecting to the Projected Coordinate System WGS 84 43N, clipping the DEM of the Area of Interest, and Georeferencing Toposheets. To extract the drainage and trace lineaments, the following steps were taken.
3. **Drainage Channel Extraction-** The drainage of the study area was extracted using GRASS and SAGA tools in QGIS software, following these steps.



4. **Lineament Map-** Identifying lineaments can reveal important information about concealed tectonic and structural elements. By utilizing a shaded relief DEM with varying Z values and Azimuths, QGIS software can effectively extract the majority of linear features.

III. Results and Discussion

To understand how ravines and trunk stream drainage are controlled in the Lower Chambal Valley's fluvial landscape, we followed a specific approach. First, we extracted the drainage of the ravines along the Chambal River at a few intervals and used the drainage traces to create a lineament map with drainage and a rose diagram of the lineament. Then, we compared these maps with those of lineament from exposed rock formations in the LCV area. We selected seven blocks for drainage lineament in the study area and correlated them with one exposure of the Vindhyan Supergroup of Rocks and one exposure of Bundelkhand Granitic Massif, which underlined the study area and were displayed in figure 3.

Here are seven detailed maps showing the drainage lineaments of blocks A, B, C, D, E, F, and G.

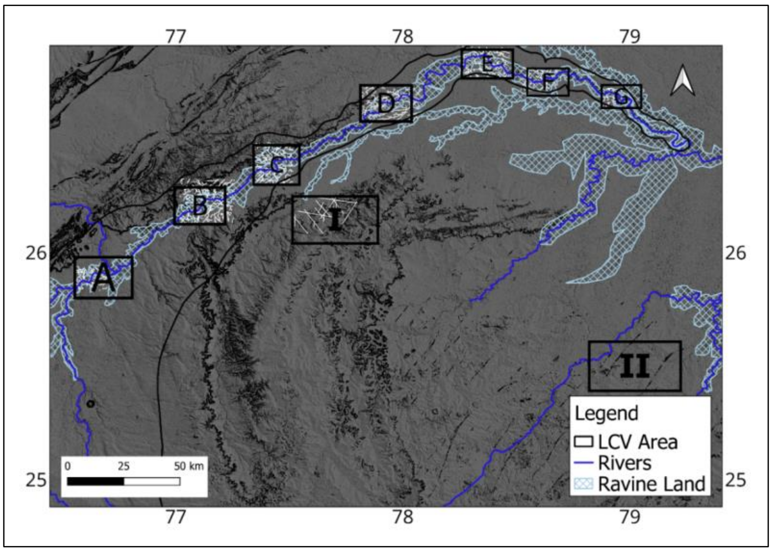


Figure 3 Shows Seven Blocks Selected for drainage- lineament extraction of Ravines are A, B, C, D, F, G and two blocks of rock exposure are I for Vindhyans and II for Bundelkhand Granite

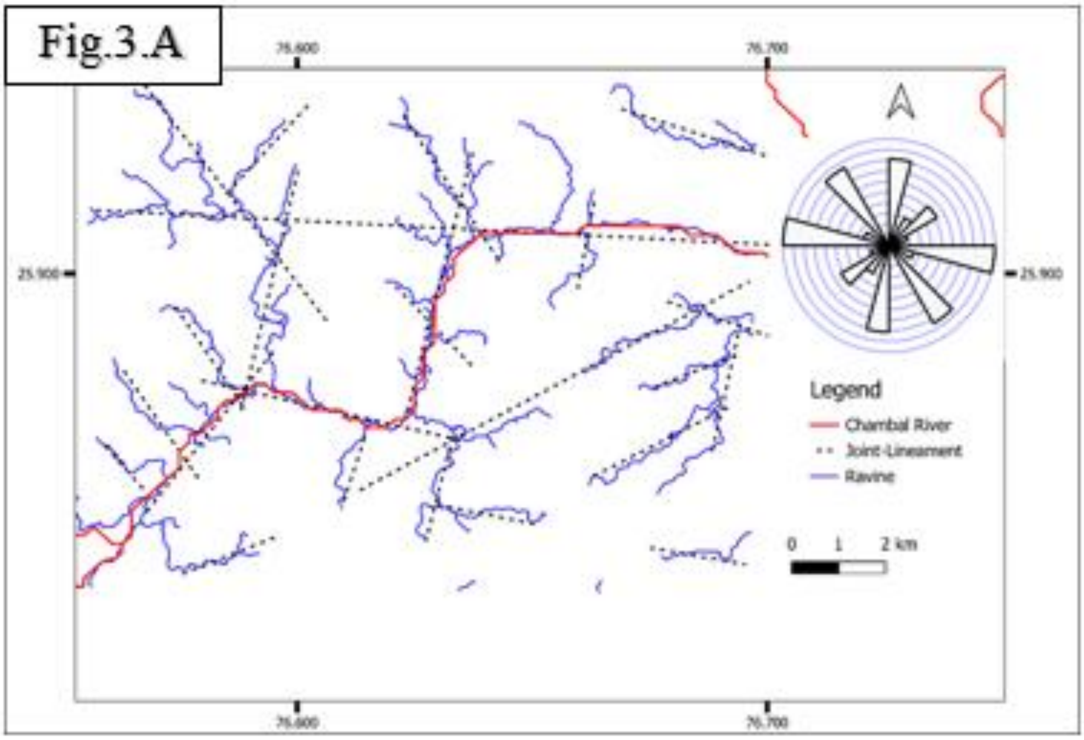

Legend
Chambal River
Joint-Lineament
Ravine
0 1 2 km

Fig.3.A

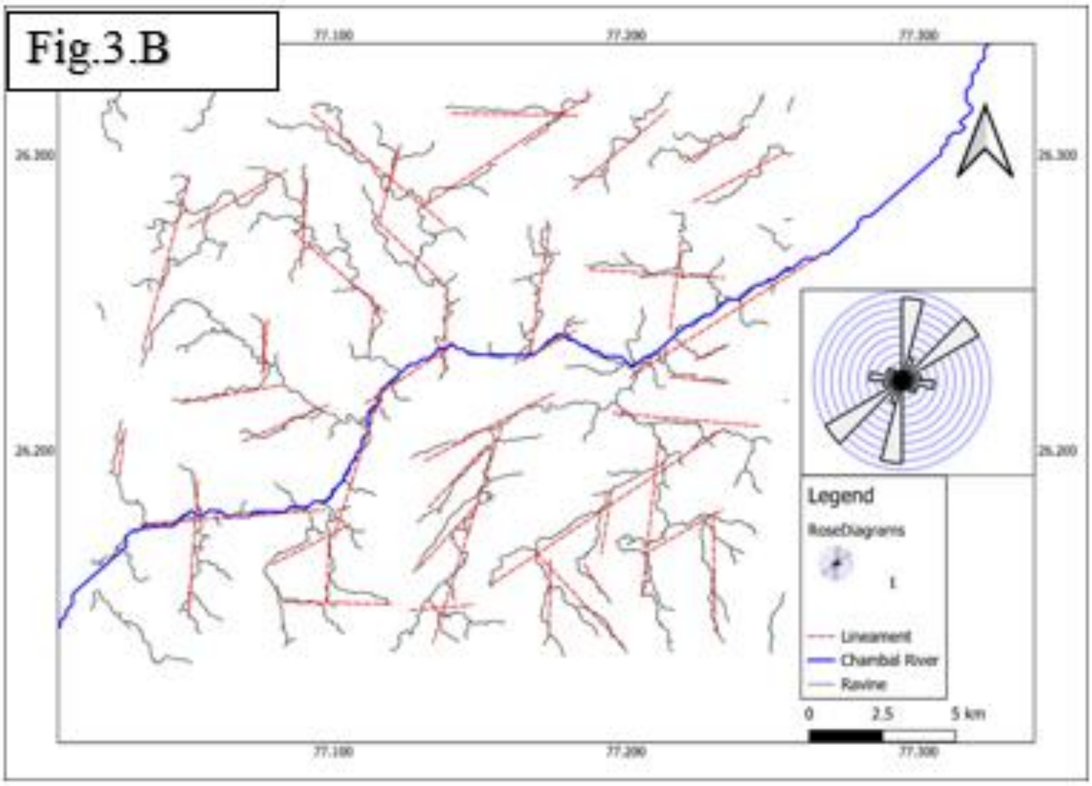

Legend
RoseDiagrams
Lineament
Chambal River
Ravine
0 2.5 5 km

Fig.3.B

Fig. 3.C

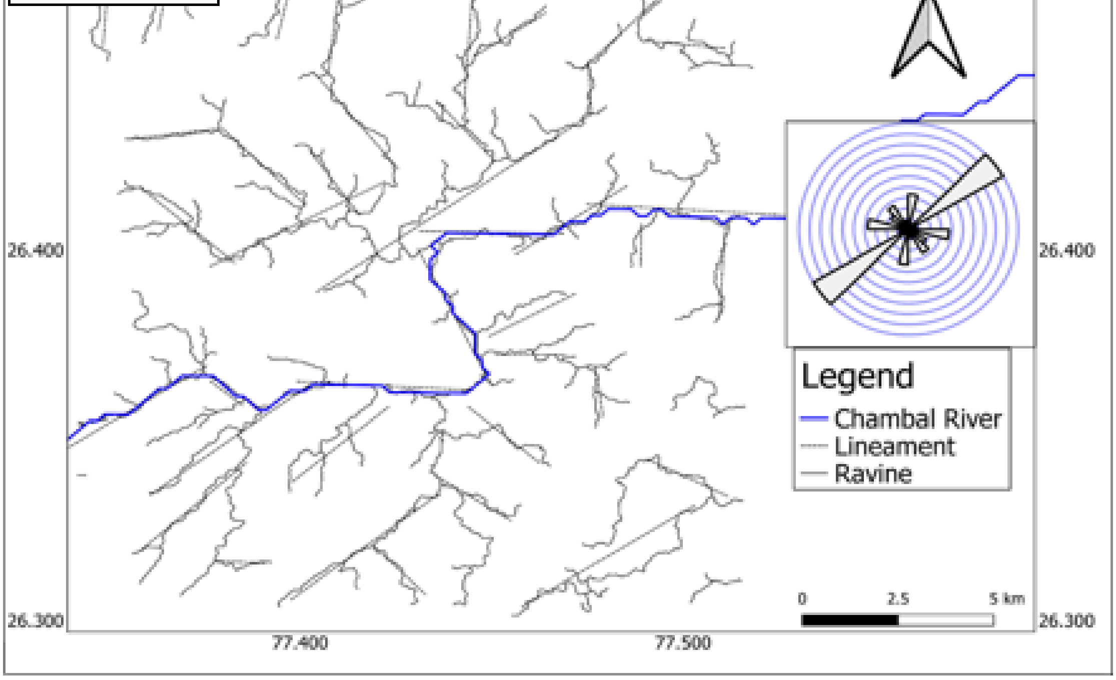

77.400
77.500
26.400
26.300
Legend
Chambal River
Lineament
Ravine
0
2.5
5 km

Fig. 3.D

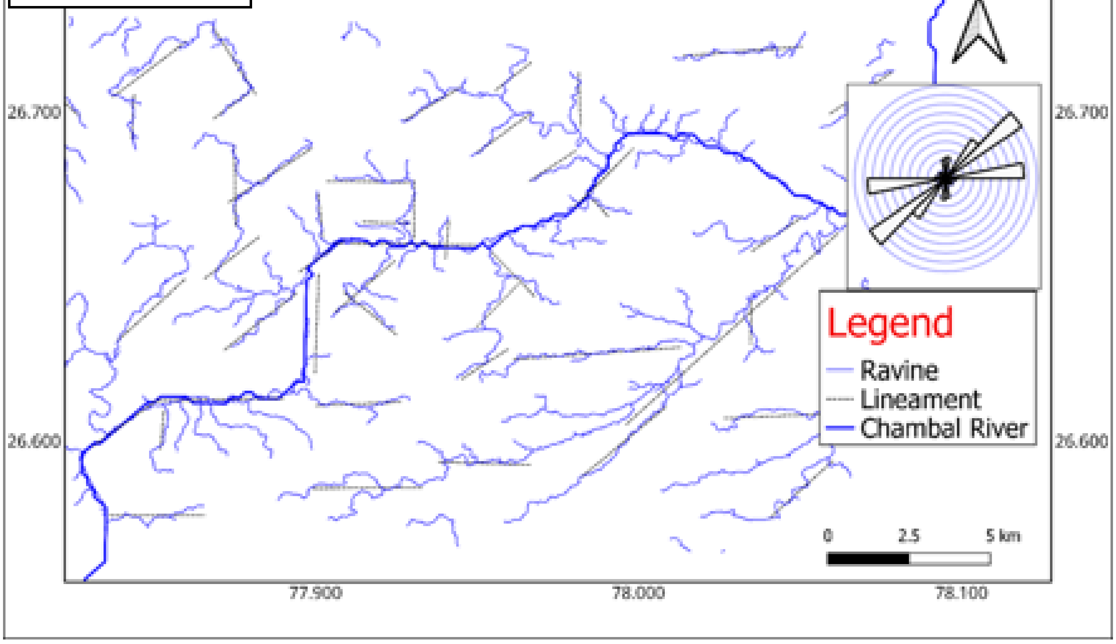

77.900
78.000
78.100
26.700
26.600
Legend
Ravine
Lineament
Chambal River
0
2.5
5 km

Fig. 3.E

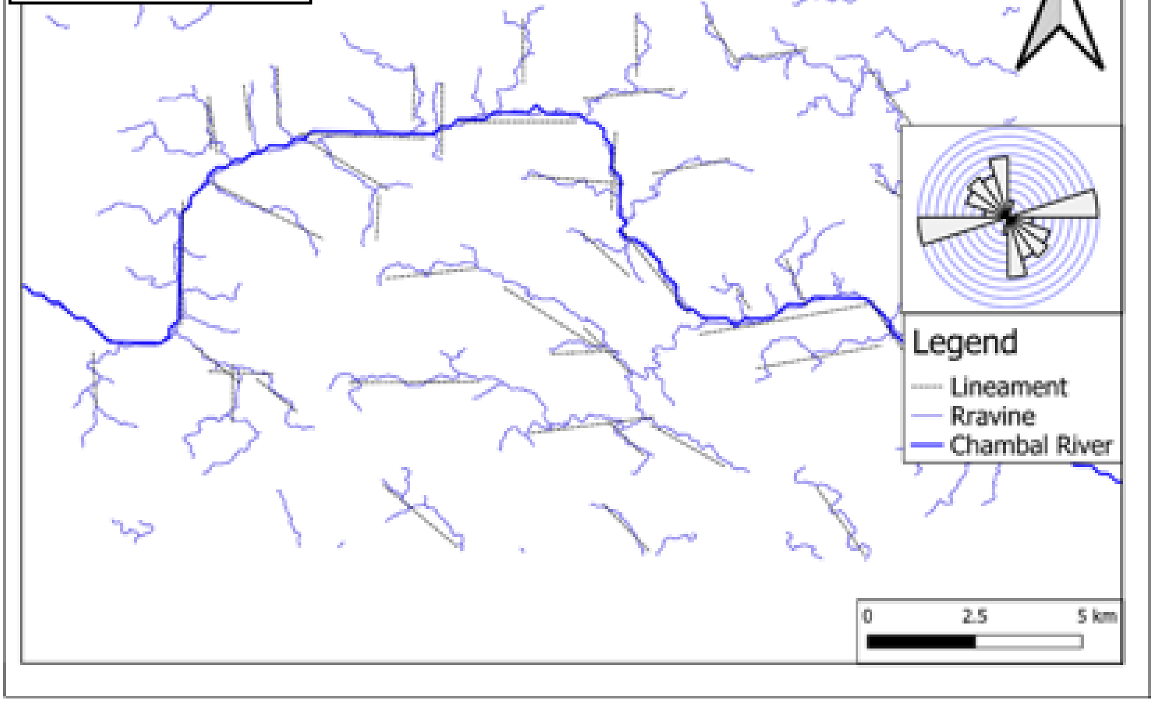
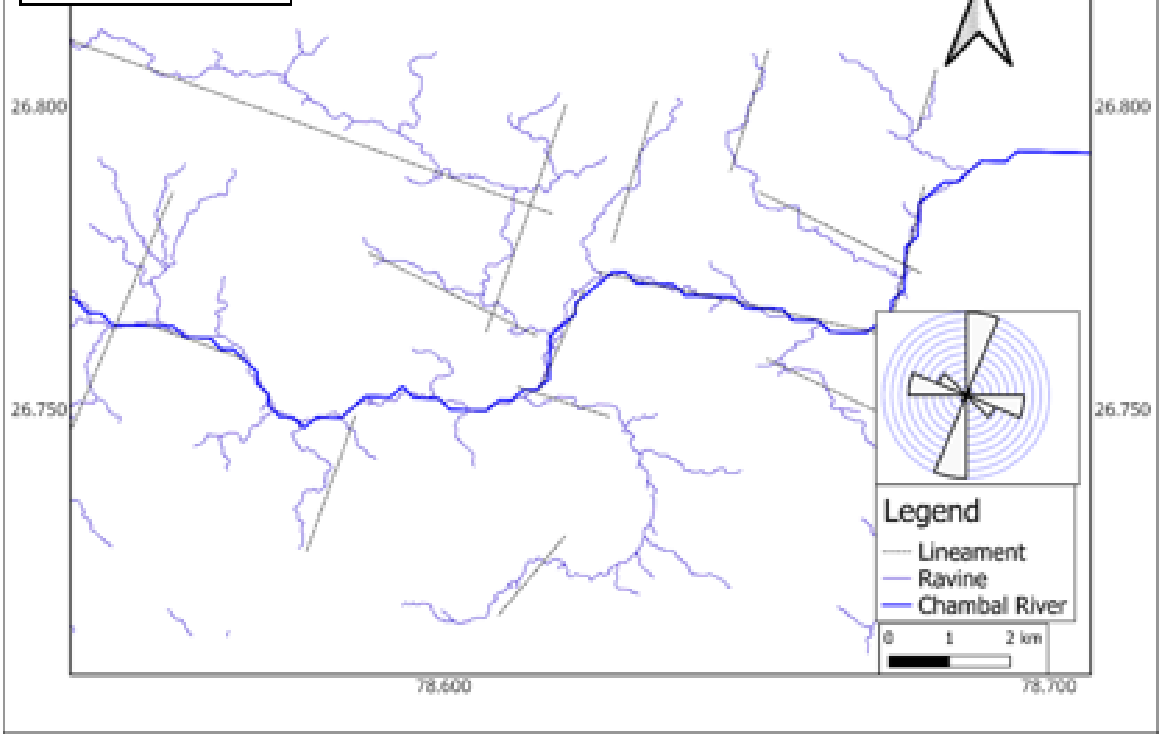
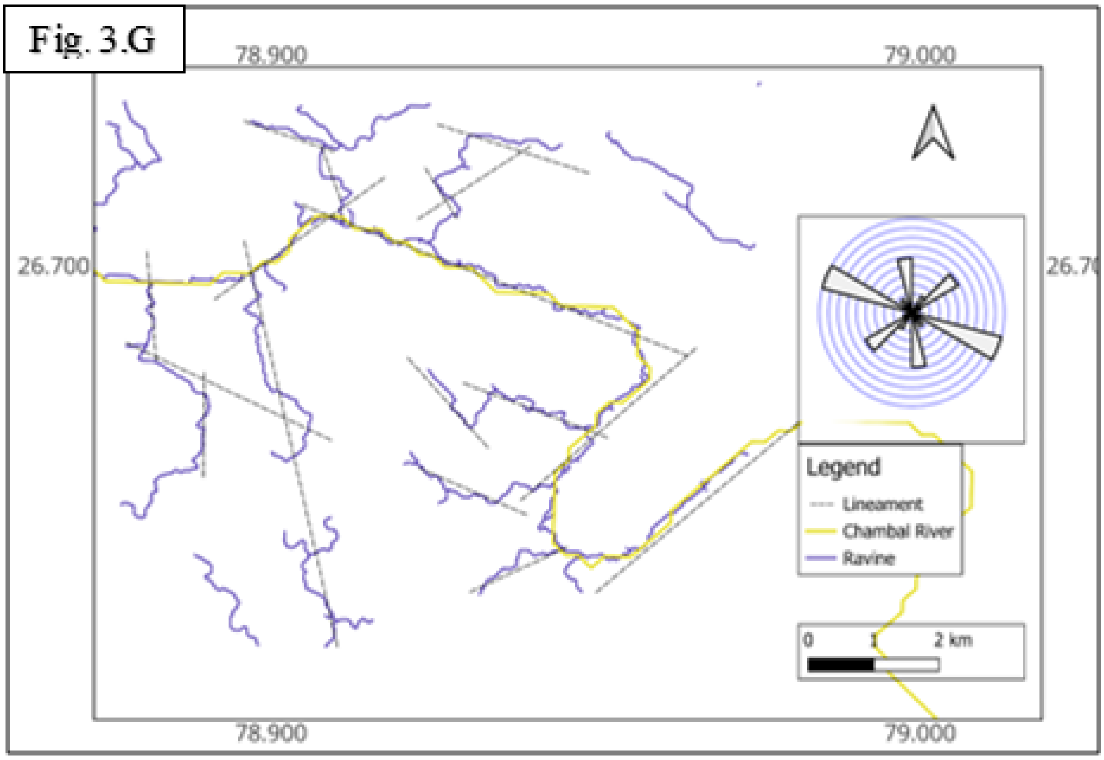

Legend
Lineament
Rravine
Chambal River
0
2.5
5 km

Fig. 3.F


78.600
78.700
26.800
26.750
Legend
Lineament
Ravine
Chambal River
0
1
2 km



The drainage patterns in various blocks exhibit angulate and are formed by streams that follow multiple lineaments. Block A has four sets of lineaments, with prominent directions near N-S, near E-W, NE-SW, and NW-SE, which join at both acute and obtuse angles. Block B has an angulate drainage pattern with streams following three sets of lineaments in directions near N-S, NE-SW, and near E-W. Similarly, Block C also has an angulate drainage pattern with four sets of lineaments, the major one being in the NE-SW direction, while the others are in directions near N-S, near E-W, and NW-SE. Block D has pinnate and angulate drainage patterns formed by two sets of lineaments in the NE-SW and near E-W directions. Block E has an angulate drainage pattern with three sets of lineaments in directions near N-S, near E-W, and NW-SE. The drainage pattern in F Block is rectangular and is formed by two sets of lineaments in directions near N-S and near E-W. Finally, Block G has an angulate drainage pattern with streams following three sets of lineaments in WNW-ESE, near N-S, and NE-SW directions. The lineament maps show that there are four sets of lineaments that are commonly found in the various blocks that were studied in detail. These lineaments trend mainly in the near north-south, near east-west, northeast-southwest, and northwest-southeast directions. In the ravine maps, these same four sets of lineaments are common, and they are also present in the lineament sets of the Vindhyan Exposer (as shown in Figure 4). However, there is one lineament that is particularly unique: it falls on a thick alluvium zone in G block, and it is situated close to a Ganga-Yamuna Fault in the vicinity. This lineament trends in the WNW-ESE direction and is not commonly found. The Great Boundary Thrust in NE-SW, Chambal Thrust near N-S, Ganga-Yamuna Fault, Mukundwara Fault, and Quartz Reefs in NE-SW trend all represent these five trends.

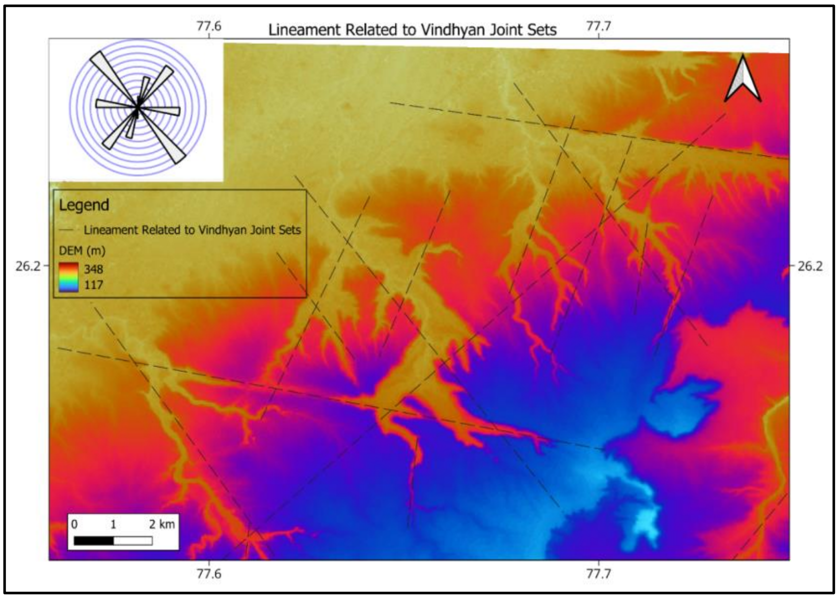


Figure 4. In Block I, depicting the Vindhyan Rock Exposures, The DEM also displays lines of depressed areas, which are marked by dashed lineaments.

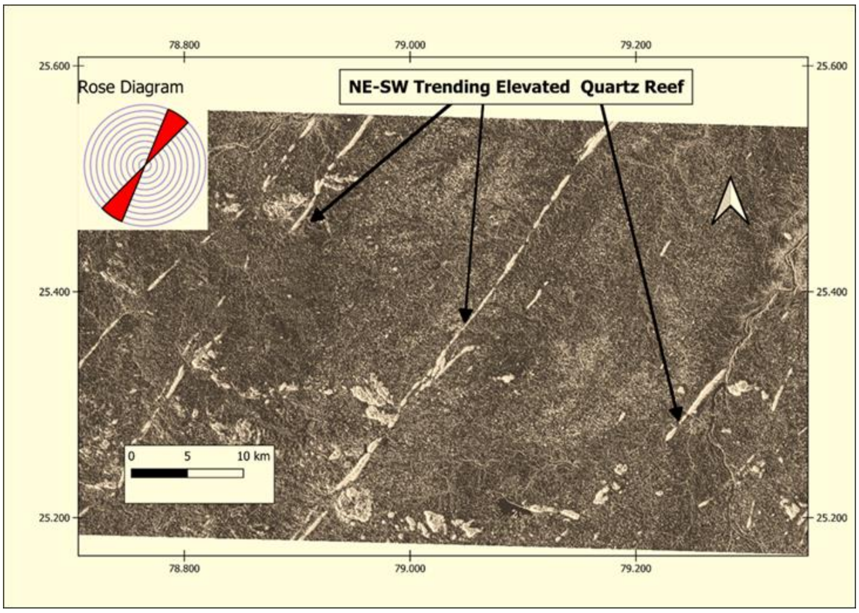


Figure 5. The Quartz Reef in the Bundelkhand Granitic Massif is shown in Block II, represented by light-colored NE-SW lines in the DEM.

The Vindhyan Supergroup of Rocks has been found to have four distinct joint sets, which are oriented N10°W to N25°W, N60°E to E-W, N35°-40°W, and N15°-20°E, as reported by **Ramteke and Chellani in 1989**. These joint sets are consistent with the lineament sets observed in the study area and those extracted from the topography of the exposed Vindhyans (see Figure 4).

The Bundelkhand Granite Massif contains Quartz Reefs that trend in a NE-SW direction (see Fig. 5). The region also has common joint sets that trend in both NW-SE and NE-SW directions, as documented by **Jha and others in 1985**. These joint trends and reefs align with the lineament trend of the study area (see Fig. 6).

The channels within the ravine zones exhibit angulate drainage patterns that appear to be structurally controlled. The lineament patterns resemble joint sets observed on Vindhyan and Bundelkhand Granite outcrops, indicating that the structural architecture of these ancient rock stratigraphic units is influencing present-day drainage. The presence of a controlled ravine network on thick alluvium suggests that there may have been a neotectonic reactivation of the old structural architecture in the study area region.

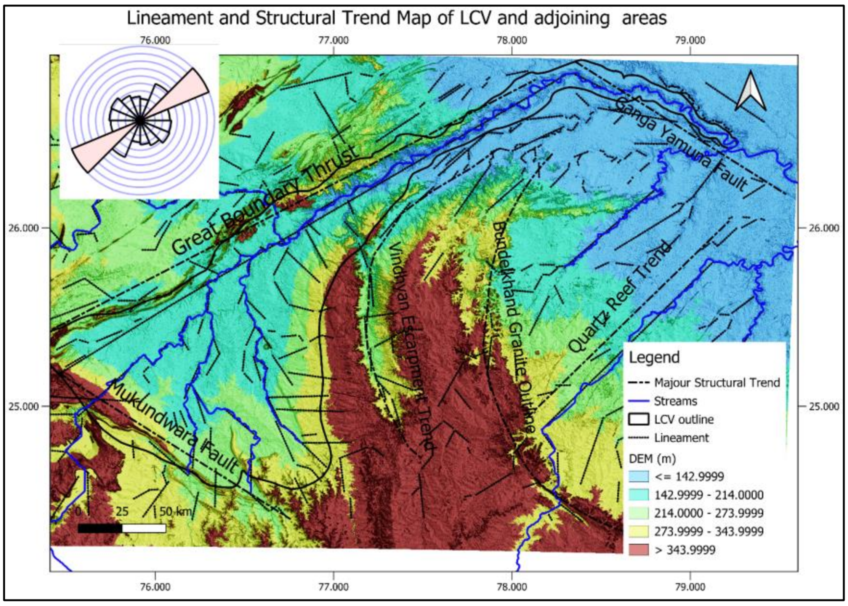


Figure 6 Lineament and structural trend map of the LCV and Adjoining areas

IV. Conclusion:

The Lower Chambal Valley's alluvium is perfect for investigating geomorphology using geoinformatics. Our research shows that the area's geological traits are affected by the reactivation of old structures of underlying rock formations. This is evident from the angulate drainage pattern of the ravine network and the similarity in lineament sets that correspond to Vindhyan and Bundelkhand Granites. The presence of lineament-controlled drainage in the thick alluvium indicates a possibility of neotectonic reactivation in the region.

V. Acknowledgement:

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