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# Geology and Structure Analysis of Palanpur-Danta Area, North Gujarat Using Remote Sensing and GIS

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## Abstract

In this research paper, The GIS and remote sensing data for allowing detection of structural features, such as faults, offers opportunities to improve, mapping and identifying the areas that are likely to be locations of faulting. Faults are weakness zones in the brittle part of the lithosphere, along which the movement can take place in response to an induced stresses. When faults undergo displacement, depending on geological and structural conditions, strain markers could be formed on the fault surface. Computer technology, such as computer-based geographic information system (GIS), supplies a different method for data storage, integration, analysis, and display. The combination of remote sensing and GIS provides an optimum system for various geological investigations such as fault mapping.

**Keywords:** Geology; Structure analysis; GIS; Remote sensing

## Introduction

The broadest geomorphic divisions of India are the Peninsular India, the extra-peninsular India and the Indo- Gangetic Plain which are also the three broadest tectonic divisions of India. The Peninsular India comprises the Indian Shield and its Proterozoic and Phanerozoic covers. The extra- peninsula constitutes a part of the Alpine-Himalayan Tertiary mountain belt The indo-Gangetic Plain extends from the mouth of Indus River in the west to the great deltaic Sunderban in the east. The Indian Peninsula comprises four major cratons viz Dharwar, Bhandara, Singbhum and Bundelkhand that are bordered by Aravalli-Delhi, Satpura-Singbhum and Eastern Ghat mobile belts. The Aravalli mountain range is the northern crustal segment of the Indian peninsula trending northeast- southwest. The Aravalli mountain Range which fringes the northwestern margin of the peninsular Indian shield runs for more than 700 km from Delhi in the shield to north of Ahmedabad in the south. Though to be one of oldest mountain ranges in the world, it comprises mountain and ridges.

## Study Area

The study area falls within parts of the Survey of India toposheets no. 45 D/11, 45 D/15 and 45 D/16. The area includes various topographic features which are mainly originated due to Aravalli tectonic activity. Geologically, the area is comprised of metamorphic rocks of Delhi Super group. Major rock types include biotitic gneiss, calcsilicate rocks and granites. The region is characterized by structural deformations induced during orogeny which allowed the rocks to be folded and refolded for at least three cycles. Drainage in the area is mainly non perennial and follows the regional gradient i.e. NE to SW.

## Previous Work

Middle miss, Hacket and many others have pioneered the work on Rajasthan geology. Studies by Coulson, Gupta, Gupta and Mukherjee [1-3] helped to establish the basic framework of the Precambrian geology of Rajasthan. Heron included the met sedimentary rocks and igneous intrusions present in the study area, within in the Delhi System belonging to the Alwar and Ajabgarh series. Later these metasediments were included in Kumbhalgarh Group of the Delhi Supergroup by Gupta [4]. They described the basic and ultrabasic rocks as ophiolites and the granites as Sendra-Ambaji granite. Biswal [5] worked on the shear zone under consideration for the present study and concluded that the area has a continental arc setting.

## Methodolgy

The following methodology is being adopted in the present study:

1. Collection of literature of the study area to undertake regional geological set-up and to have a broad idea on the present state of the affairs.

2. Collection of various remote sensing data.

3. Field work in the study area. Structural features are noted with their attitudes with the help of Brunton compass and Systematic field measurements and sample collection done wherever variation is seen.

### Data used

GIS and remote sensing data for allowing detection of structural features, such as faults, offer opportunities for improving mapping and identifying the areas that are likely to be locations of faulting areas. Landsat 8 satellite data images were used and band-5 was found as the most suitable band for lineament delineation, based on the ability to identify geological features. Four contributing factors, namely, drainage patterns, faults (previously mapped), lineaments, and lithological contacts layers, were parameters used in this study.

Faults are weakness zones in the brittle part of the lithosphere, along which movement can take place in response to induced stresses. When faults undergo displacement, depending on geological and structural conditions, strain markers can be formed on the fault surface.

The presence of faults may be indicated by these geological features (factors).

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The term lineament was first introduced by the existence of linear geomorphic features and interpreted them as surface expressions of zones of weakness or structural displacement of the earth's crust. Lineaments are linear features on the Earth's surface, usually related to the subsurface phenomena. Generally, lineaments are related to large fractures and faults where their orientation and number give an idea of fracture pattern of rocks. In the recent years, the lineaments have been defined as natural crustal structures that may represent a zone of structural weakness. The drainage system, which develops in an area, is strictly dependent on the slope, the nature, and attitude of bedrock and on the regional and local fracture pattern. Most stream networks are adapted to regional slope and geological structures, picking out the main fractures in the underlying rocks. Thus the contact between two lithology's can also appear as a linear feature. This contact may appear as a change in drainage pattern across the structural features or the two units may have different spectral properties. Computer technology, such as computer-based geographic information system (GIS), supplies a different method for data storage, integration, analysis, and display. The combination of remote sensing and GIS provides an optimum system for various geological investigations such as fault mapping [6].

Once the identification, preparation, and processes are complete, geographic information systems (GIS) functionality, such as vector and raster spatial analysis and overlay, can be employed for structural mapping and analysis using powerful software programs.

### Regional geological mapping - Lithology and structure

After a close study of all available geological information on the area, the next step is to overlay, in a GIS, any existing geological maps, in image or vector form, on false colour composites of Landsat imagery and on hill-shaded DEMs, either SRTM or ASTER. This will serve as a quick check on the reliability or otherwise of the existing maps, and the amount of information likely to be added by remote sensing interpretation. The next step is to interpret geological structure. The main features visible in remotely sensed imagery and DEMs are faults, shears and fractures, plus lithological boundaries between rocks of differing resistance to erosion [7]. The first steps in structural interpretation are shown in Figure 1, where linear features are interpreted from SRTM and Radar images. All interpretation is done on-screen within a simple GIS package (Figures 2 and 3).

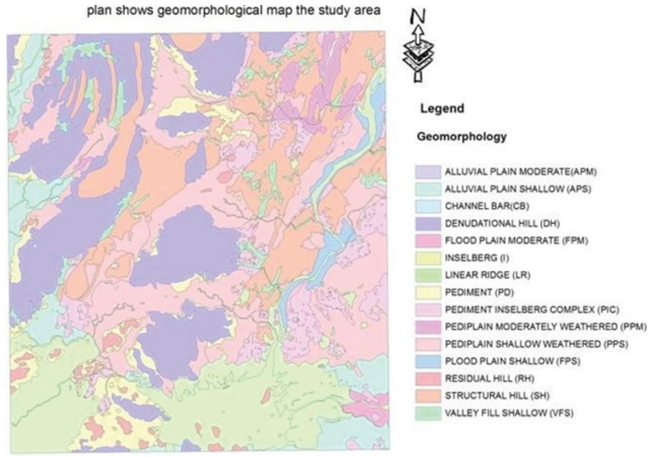


**Figure 2:** Plans showing geological map of study area.

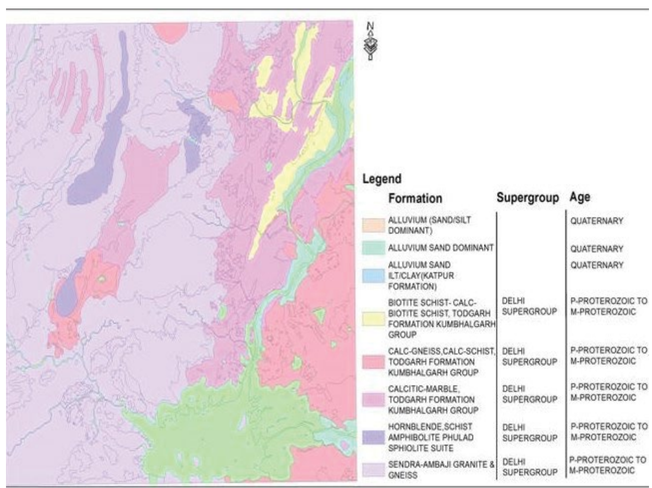


**Figure 3:** Study area of geomorphology.

## Structural Pattern in Delhi Group

Detailed structure studies in the rocks of the Delhi Group have been carried out by a number of workers. Structures of four generation (DF1-DF4) are decipherable in the Delhi rocks. Structure of first two generation is ubiquities in all scales, and the structures at last two phases have developed in some sectors. The DF1 folds are very tight to isoclinical with a pervasive axial planar cleavage (S1). These folds have affected the stratification planes only. The folds of the second generation (DF2) have developed on stratification as well as S1. These folds range from open to so clinical style, with vertical axial planes striking NNE-SSW to NE-SW. A c renulation cleavage (S2) has developed parallel to the axial planes of these folds. The DF2 folds are strictly coaxial with DF1 folds. Both DF1 and DF2 folds show all the characteristic of buckles folding. The upright DF2 fold with NE-SW striking axial planes must have developed by a horizontal NW-SE compressive strain acting on subhorizontallayring. The folds of the third generation (DF3) are kink folds with subhorizontal axial planes. These folds have affected axial surface of DF1 and DF2 folds and S1 and S2 cleavage. At places the DF3 folds have conjugated axial planes striking NE-SW and NW-SE. DF3 folds were formed by vertical compression. The folds of the last generation (DF4) are upright chevron folds with NW- SE striking axial planes. Locally conjugate DF4 folds with N-S and E-W striking axial planes have developed. The DF4 structure have been caused by a horizontal compression in an NE-SW direction [8].

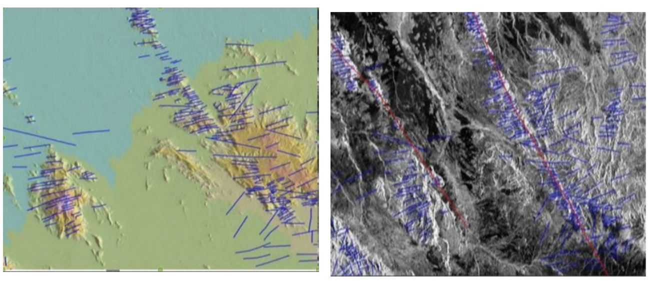

**Figure 1:** Linear features are interpreted from SRTM and Radar images.

The Delhi group rocks have been intruded by acidic igneous rocks of two phases. The earliest granites are found in the Alwar sub-basin and the Khetri area. These granites give an RB-SR age of 1600 Ma. And more widespread along the Aravalli range and west of it. These granites are syn to post –DF2 in age.

Traced the effect of diapiric intrusion of younger granite on the structure of Delhi rocks. According to them the reorientation of the folds.

## Conclusion

The Study area, ductile shear zone is a tabular, planar band of definable width in which there is considerably higher strain than in the surrounding rock. The total strain within a shear zone typically has a large component of simple shear, and as a consequence, rocks on one side of the zone are displaced relative to those on the other side. Ductile shear zone is found in middle to lower crust and Asthenosphere.

Mostly under metamorphic conditions. Study area is lithologically composed of granite, gabrro-norite-basic granulite and mylonite (quartzo-feldspathicmylonite) where shear zone is extending NW-SE having more or less parallel boundary. Gabbro-norite basic igneous intrusion took place, and then acidic granitic igneous intrusion emplaced within Gabbro-norite intrusive body during late phase of Delhi

orogeny and contact zone between these two intrusives was metamorphosed to granulite facies, i.e mafic granulite with emplacement of amphibole by metasomatism in this transition zone. These basement rocks are overlain by granite in this area as believed that granite is laterally extended. Then the entire formation is deformed and as a result mylonite was formed from granite in the shear zone but contact zone between granite and gabbronorite experienced deformation in small proportion which has shown in thin section but not so prominent that has been seen in mylonite because of its mineralogy that resists to shearing. This is based on the thin section study. This shearing took place as a subsidiary to the Kui-chitraseni shear zone deformation during Delhi orogeny. There are two faults cross cuttinthe shear zone which are parallel trending N50$^{o}$. The direct field evidence is distinct but Geomorphology and shifting of shear zone boundary highly support it. These faults are very late phase deformation as it can only happen when all the formation is exhumed so that brittle deformation took place. The mylonitic foliation is steeply dipping towards southwest and the northeastern granitic block is uplifted and southwestern block is gone down based on the attitude of the stretching lineation as well as mylonitic foliation and sense of shear on this shear zone. For the fault F', the northwestern block is uplifted relative to the southeastern block which is indicated by southwestern shift of boundary. For the fault F", the relative movement is same as that of fault F'. The sense of shear zone is left lateral strike slip to slightly oblique in nature based on the analysis that has shown in previous.

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