LANDSAT-TM IMAGES IN GEOLOGICAL MAPPING OF SURNAYA GAD AREA, DADELDHURA DISTRICT WEST NEPAL

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KEYWORDS: LANDSAT-TM, Color Composite, Lithology, and Traverse.

ABSTRACT

Geological mapping in Nepal is generally carried out on the basis of field observations by taking traverses along some routes (trails, and river courses). Traverses have to be limited due to rugged terrain conditions and are often time consuming. Aerial photographs have been utilized for such purpose. However, photographs are often distorted laterally and do not provide an overall view of an area. Satellite Image such as LANDSAT-TM scene provides excellent image characteristics with synoptic view of large areas in different band combination.

In this regard, a False Color Composite (FCC) in 4,3,1 of LANDSAT-TM Image and Aerial photographs was used for the present investigation. The study covers an area of ~650sq.km. The image was interpreted using a transparent overlay for delineating possible lithological boundaries and tectonic features of regional significance prior to the field investigation. A number of traverse routes were planned to verify Image features such as tonal difference, drainage pattern and other morphological features of different rock units.

The information obtained from the field, Satellite data, Aerial photos and previous maps were transferred into a topographical base map. Based on these data a geological map at a scale of 1:50,000 have been prepared. Image characteristics of granite terrain are found to be less dissected than the areas occupied by phyllites and slates. The contact /boundary between granites and slates established in the field could be extended to inaccessible areas. Similarly, the limestone occurrence recorded along some sections could be mapped on the image through out the area. Most of the lineaments observed on the image were found to be faults. Effects of these faults are observed on displaced ridges, river courses and lithological contacts.

The LANDSAT-TM Images have been effective tools in extending lithological contacts and tectonic structures verified during field checking. Rock units are often covered by vegetation and soil developed on them. Drainage patterns of various lithological units are recognizable with experience.

1. INTRODUCTION

The study area is a part of the Lesser Himalayas in west Nepal situated at the Indian boarder (fig. 1). Kali River, an antecedent stream marks the country border in the west of the area. Surnaya Gad, Pelia Gad and Rupali Gad are the major tributaries of the Kali River. The lowest elevation in the area is 1266ft near the confluence of the Surnaya Gad and the Kali River. The highest elevation is 8316ft at Gwallekh. There are high rugged mountains and deep narrow valleys all over the area. The area is between latitudes 29° 15' 0 to 29° 30' 0" and longitudes 80° 15' 0" to 80° 30' 0". The study covers an area of 650sq.km.

2. BACKGROUD

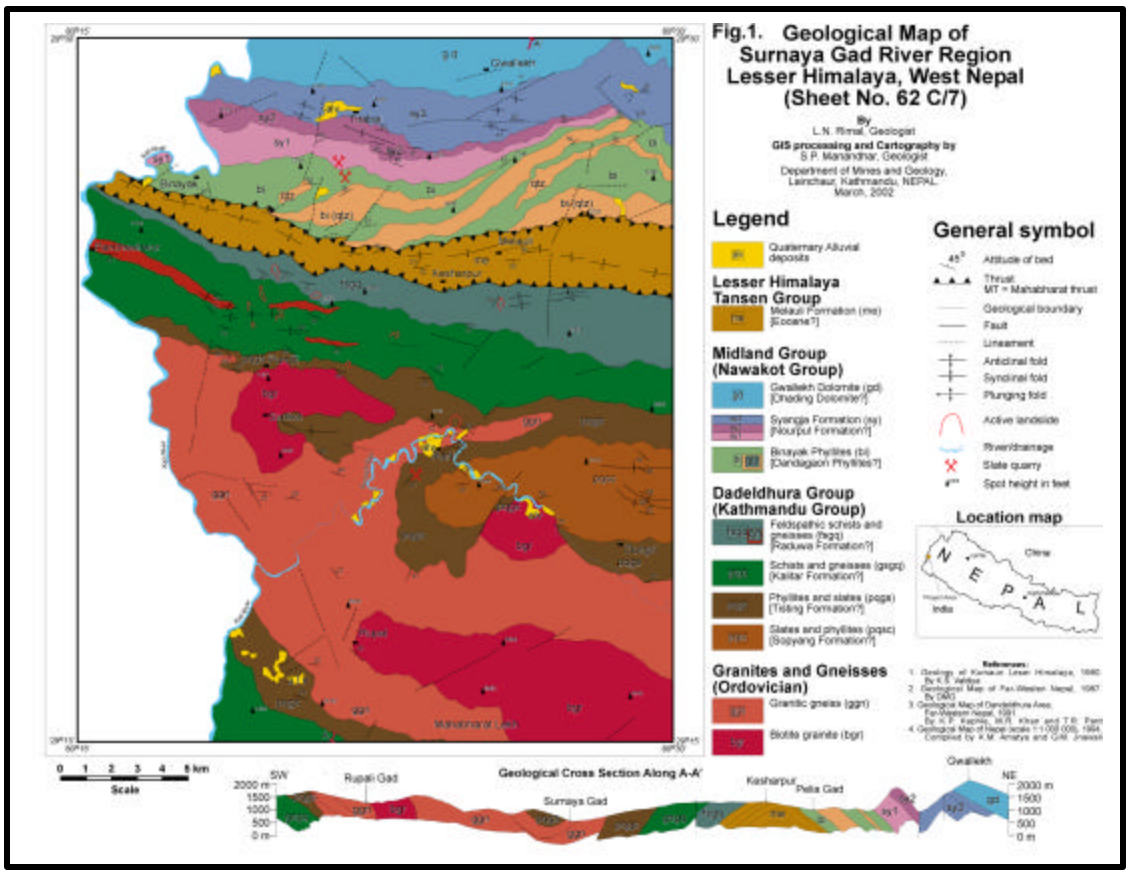
Reconnaissance level geological studies were done by Gansser (1966), Hagen (1969) and others taking traverses along some routes across the Himalayan range. Joshi (1978) carried out geological mapping during mineral exploration program of the Department of Mines and Geology. Valdiya (1980) recognised several geological groups and formations during the geological research of Kumaun Lesser Himalaya, India. Land Resources Mapping Project (LRMP, 1984) did geological mapping using aerial photographs and delineated major tectonic lineaments and rock units. Bashyal (1981, 1986) has recognized two main tectonic units, Bunder meta-sedimentary unit of parautochthonous character thrusted over by

Dadeldhura complex. Kaphle (1992) investigated the Dadeldhura Granite Massif and concluded that the granite is one of the Lesser Himalayan cordiarite bearing two mica granite of 470 ± 5.6 Ma age.

Synthesis of the existing geological maps shows variation in geological boundaries drawn between the rock units. Some rock units with specific geomorphic expression on aerial photos and with different composition were not mapped as different unit. In this study, an attempt has been made to find solutions over such discrepancies using satellite imageries and aerial photos.

The study program was planned for the following objectives:

- To verify the result of image interpretations and to review the results of previous works with a view to prepare a geological map at a scale of 1:50,000 of a part of the Far West lesser Himalaya;
- Recognition of image characteristics of various lithological units in LANDSAT TM-Scene of the area to see the applicability of the LANDSAT -TM in similar terrain;
- Delineation of tectonically weak zones.



3. DATA COLLECTION AND INTERPRETATION

3.1. Desk Study

Assessment of the existing geological maps before field investigation reveals the various longitudinal and transverse faults, and thrusts. Some of them are also recognized in the image. One of the major lineaments that cross the Dadeldhura massif has not been delineated in the earlier maps. Some of the lineaments identified in the satellite image are also mapped in the exiting maps as faults.

Lineaments are marked on the TM-Scene in the proposed working area (fig. 2). Most of these lineaments are oriented mainly in E-W and NE-SW directions and sometime there are also N-S and NW-SE directed

ones. These lineaments could be the deep-seated faults or fracture zones, the boundary of the lithological variations and to the most they normally represent the tectonically weak zones.

Digital image processing has been carried out in the following steps:

- False Colour Composite (to see geomorphic expression of rock units)
- High pass filters (to enhance the drainage and lineaments)
- Principle Component Analysis
- Edge detection

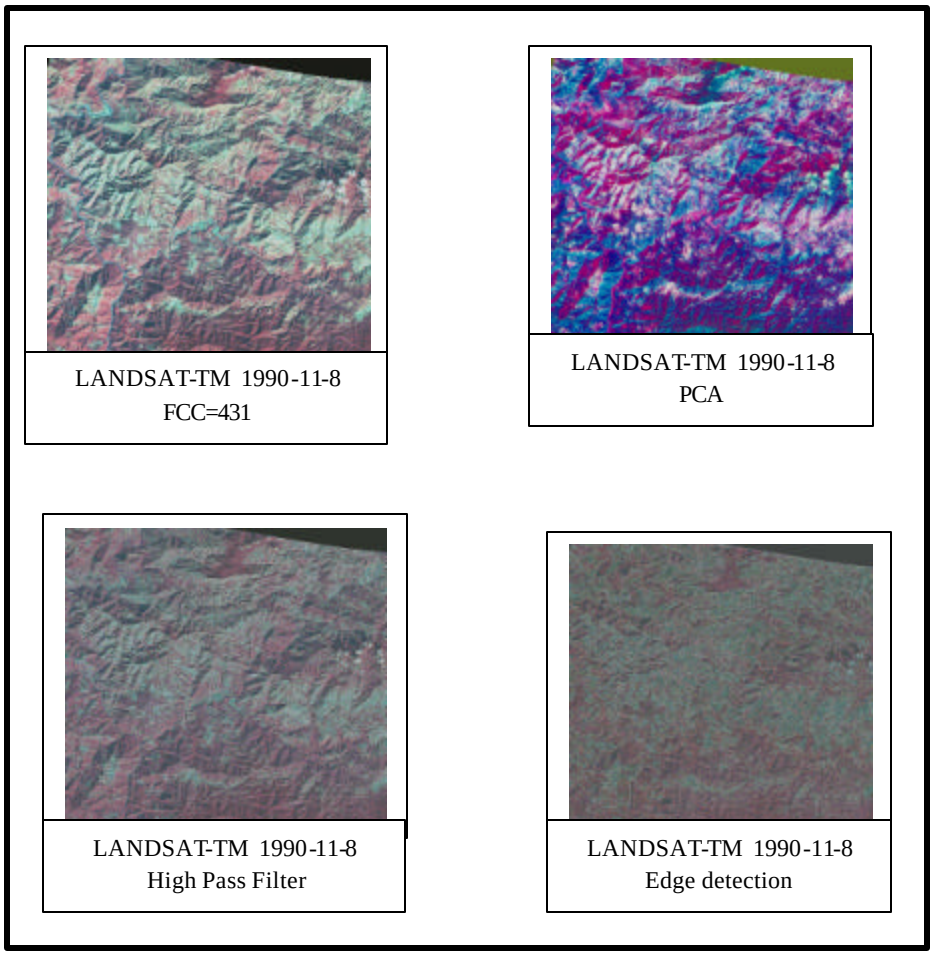


Fig 2: LANDSAT-TM Images and example of some digital image processing

3.2. Field Verification

The study was carried out with an aim to verify the lineaments in the field as well as previously identified thrusts, faults, lithological formations and boundaries. Lithostrtigraphic sequence for the area was compared with the established lithostratigraphy (Stocklin, 1980) of Central Nepal Lesser Himalayas. Traverses were taken along previously planned routes with some modification as per the field condition.

Emphasis was given to concentrate on the cross-zones of differently oriented faults or lineaments to find out the possible relation between the known mineralized localities and the cross-zones. In addition, the detail study of joint- sets in various lithological units was carried out. Furthermore; major joint direction was compared with the major linear features in the area to get proper orientation of the fracture zones.

4. INVESTIGATION RESULTS

Soil or vegetation in most of the study area covers bedrock. Therefore the cover material masks the reflectance from rock leading to difficulties in capturing direct radiation essential for geological interpretation. An indirect approach is adopted to incorporate remotely sensed information in the present investigation. Geomorphic expression reflected by the rock formations such as drainage texture, positive and negative landforms and cultivation patterns depicted in the LANDSAT-TM image was utilized to recognize the extension of the rock formations. Based on field verification and image characteristics following rock and soil units are identified in the area:

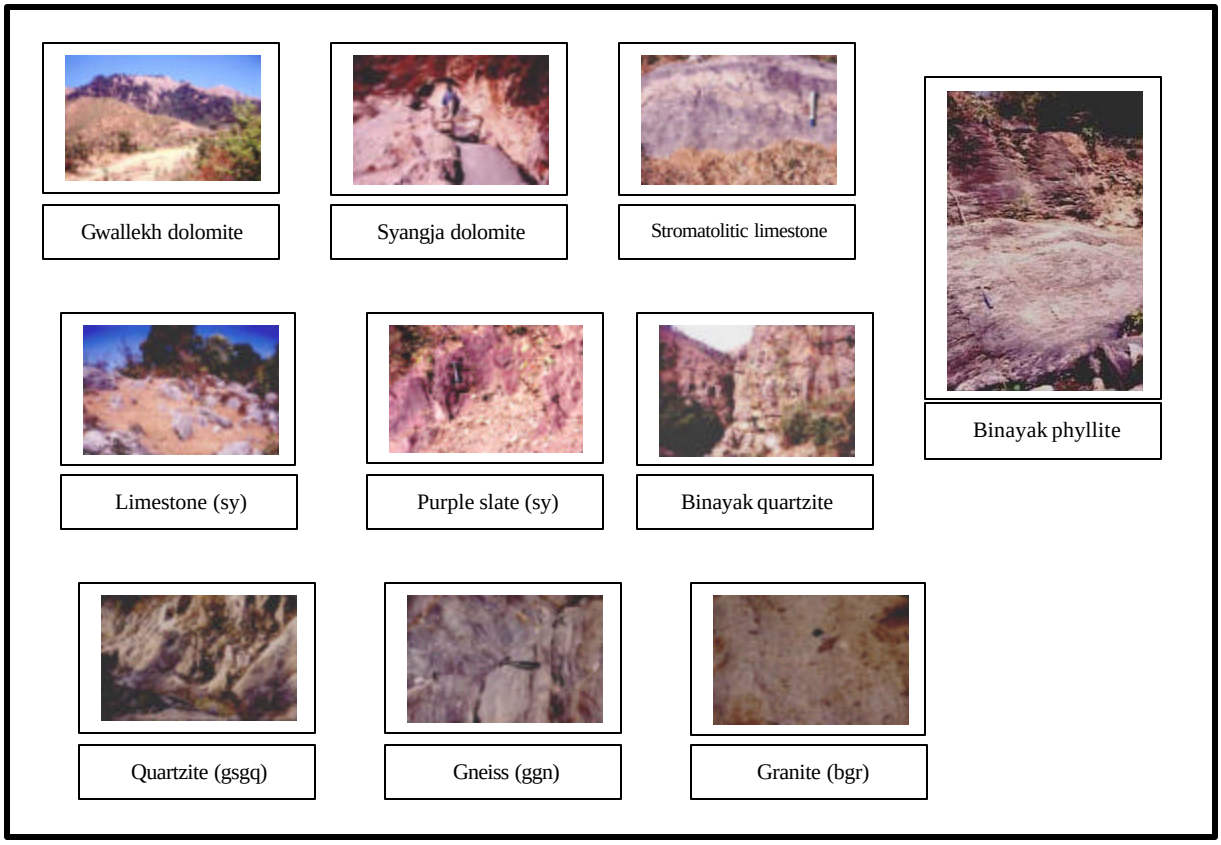


Fig 3. Rock exposures of different geological formations observed during field verification.

Quaternary Alluvial Deposits (alv): The deposits are developed along the sides of the rivers. These deposits

Mainly consist of gravel, sand and silt. In the FCC of LANDSAT-TM these deposits are observed as patches of light blue areas.

Melauli Formation (me), Eocene ?: This unit is comparable the rock sequence of the Tansen Group. This formation is represented by sedimentary rock sequence of pink shales, green sandstones and amphibolites. Dendritic drainage, smooth and moderate hills are formed in this lithological unit.

Midland Group: Rocks of this group are tentatively correlated to the Nuwakot Group rocks of Central Nepal. This

group is further divided into Gwallekh Dolomite (gd); Syangja Formation (sy) and Binayak Phyllites (bi). These units are well developed in the northern part of the study area. There are fine to medium grained thick-bedded quartzites and grey to dark grey slates in the Binayak Phyllite Formation fig.3). Purple slates, purple dolomites and stromatolitic limestone represent the Syangja Formation (fig.3). Blue grey dolomite makes up the Gwallekh Dolomite Formation.

Dolomites and limestones form high ridges whereas deep valleys are created in slates due rapid erosion. Closely spaced drainage texture and randomly oriented streams form an over all dendritic pattern in phyllitic terrain. There are more cultivated areas as the slates give rise to soils rich in clay. Limestone and dolomite areas have comparatively sparse surface drainage as most of rainwater seeps through joints. These rocks form positive topography.

Dadeldhura Group: This group is correlated to Kathmandu Group rocks of Central Nepal**.** This group is divided into four formations namely Feldspathic schist; Schist and Gneisses; Phyllites and schists and Slates and phyllites (fig. 1). Granites are observed intruded within this group (fig.3). Valleys are developed in phyllites and schist areas. The granites form high ridges and the terrain is densely forested as it is seen in the LANDSAT-TM Image.

New localities of granite occurrence in the east and south east of Pundil village have been identified during this investigation in the middle part of the area.

5. CONCLUSION

The study revealed that the southern part of the area consist of mainly crystalline rocks such as granites, granitic gneisses, schists, and feldspathic gneisses. Dark grey slates occur above the crystallines and are folded into an open broad syncline. Granite intruded within these rock sequences during Ordovician time. The rock formations of this area are comparable to the Kathmandu and Nuwakot Group rocks of Central Nepal. There are sedimentary rocks, which are similar to Tansen Group rocks exposed in the central part of the study area.

The meta-sedimentary sequence developed in the northern part of the area are fine to medium grained thick bedded quartzites, grey to dark grey slates, purple slates, grey and blue grey stromatolitic limestones, purple dolomites, blue grey dolomites and grey slates.

The blue grey limestones developed south of Titabai village extends to the east up to Kuchagaon village. This limestone could be further investigated to determine its quality and quantity.

Several faults and thrusts are recognized in the area. A thrust fault observed south of Kesharpur brings the crystalline rocks over to the sedimentary sequence of purple shales, green sandstones and amphibolite. Direct evidence of lineament crossing zones and related mineralization could not be observed. Granitic terrain shows distinct morphologic feature especially in the south east of Pundil village. Satellite images and the aerial photographs have been useful in delineating and extending lithological boundaries, tectonic structures, quaternary deposits and recent landslides.

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