CHAPTER - II

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SATELLITE DATA ANALYSIS

2.1 INTRODUCTION :

Satellites are the one of the common platforms for remote sensing observations. Such space born remotely sensed data is used to assist in investigating,mapping and monitoring of the earth resources. In short, the reflected and emitted electromagnetic energy from the earth's surface are scanned by scanners in the satellites and data is collected. The development of multispectral scanners during 1970's made a significant contribution, as it is enable for the first time to sense beyond the visible range of electromagnetic spectrum. The remote sensing technique involves basically two processes (Lillesand and Kiefer 1987) as data acquisition and data analysis.

The major data acquisition process involves sensing the reflected and emitted electromagnetic energy. The data analysis involves study of data obtained with various viewing and interpretative devices to analysis pictorial data and use of computer for analysis of digital data.

The series of earth resources satellites as Landsat, IRS-1A and SPOT with multispectral scanner and other scanners have given more information regarding geology, geomorphology, hydrology, vegetation etc.

IRS-1A (Indian Remote Sensing Satellite) the first in IRS series of satellite was launched and commissioned by India on 17th March 1988. It was a milestone in the history of remote sensing in India. The type of imaging sensors used in IRS-1A is of Linear Imagery Self Scanner which are of two Forms as LISS-I and LISS-II.

The IRS-1A data are of immense value which provide a better base for mapping the lithounits, structural features, landforms, lineaments, drainage etc., on regional as well as local scale (Ganesh Raj (1989), Deekshatulu (1991), Patil(1992), Roy et. al.(1992)), according to above workers IRS data is equally competent as that of Landsat, which leads to better interpretation by providing information regarding soil moisture, vegetation, drainage, lithology, structure etc.

The high altitude multispectral and temporal remotely sensed data is acquired by earth resources satellites, which have been placed into polar sun-synchronous orbit. Landsat and

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IRS-1A are such type of satellites launched by U.S.A. and India respectively. The various characters of Landsat 5 and IRS-1A satellite are given in table 2.1.

2.2 SATELLITE DATA AVAILABLE :

Landsat/ IRS data are available in two forms (1) Photographic products (imagery) and (2) Digital data either in computer compatible tape (CCT) per scene or floppy products of each single band or of 4 bands (Patil, 1992).

Photographic products of satellite are available in various forms as negative and positive films, positive print and transparency in different scales. The digital data products are available in computer compatible tape and in floppy forms. Standard images which are obtained from CCT are generally on the scale of 1 : 1,000,000 with the information of longitude-latitude, spectral band, sun elevation, sun azimuth angle etc. are given.

2.3 FORM OF SATELLITE DATA USABLE AND ITS APPLICABILITY :

The favourable conditions of remote sensing

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TABLE 2.1 : CHARACTERS OF LANDSAT-5 AND IRS-1A SATELLITES

	Landsat - 5	IRS - 1A
Year of launching	1.3.1984	17.3.1988
Orbit	Sub-synchronous at at 705 km altitude	sub-synchronous 904 km altitude
Repetative cycle	16 days (233 orbits)	22 days (307 orbits)
Orbits per day	14.5	14
Local Sun time	10.30 A.M.while crossing 40 N cross	10.25 A.M.while crossing equtor
Scanning system	Cross-track scanning	Pushbroom scanning
Sensors & Number of bands	MSS : 4 bands TM : 7 bands	LISS I & II : 4 bands each
Spectral regions	MSS : 0.5 to 1.1 um TM : 0.45 to 2.35 um and 10.50 to 12.50 um	LISS I & II : 0.45 to 0.86 um
Rediometric Resolution (Gray levels)	MSS : 64 TM : 256	LISS I & II : 128
Ground Resolution	MSS : 79 meter TM : 30 meter : 120 meter for 6th band	LISS I : 72.5 meter LISS II : 36.25 meter
Terrain coverage	185 kms x 185 kms	LISS I : 148 kms x 174 kms LISS II : 74 kms x 87 kms

techniques in the geological studies are:

1) Satellite data with regional scales as 1:1,000,000; 1:125,000 and 1:250,000 provides synoptic view, which helps in identification and demarcation of lithostratigraphic units, geomorphic features and megalineaments. The enlarged imagery may demarcate different lithounits.

2) Imagery is a permanent record of existing conditions in the form of picture. This data can be studied in laboratory and field. The time required for field studies is minimised due to laboratory studies.

3) Images can record features over a wide range of spectral bands (from ultra Violet 0.3 to 0.4/um. through visible 0.4 to 0.7/um to thermal Infra red 5 to 16/um). So that the objects and processes which are beyond our eye can be recorded easily.

4) Colour composite images are produced by optical superimposition of multiple bands. The 1,2,3 bands of LISS-I and LISS-II are combined to produce normal colour composites. Whereas the individual 1,2,3 and 4 bands of LISS-I and II are combined to produce false

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colour composite FCC.

5) The digital data is more amenable to computer assisted analysis.

2.4 SATELLITE DATA USED :

The IRS-1A data has been used for present study. Two forms of IRS data has been acquired from NRSA, Hyderabad. The details of this data is given in table 2.2

2.5 METHODS OF SATELLITE DATA ANALYSIS :

The satellite data analysis has been carried out by two ways, 1)Visual interpretation and 2)Digital analysis. The visual interpretation includes examination and analysis of pictorial data by using viewing device (Magnifying lense),while the digital analysis involves the use of computer for various operations.

2.5-1 Visual Interpretation :

The visual interpretation of satellite images is carried by magnifying lenses. Generally single band photographic hard copies of satellite MSS images are used. Interpretation of any individual satellite image involves

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TABLE NO. २.२ : SPECTRAL BANDS OF IRS-1A AND THEIR APPLICATION

Satellite and Sensor	Bands	Spectral range (um)	Applications
LISS I and II	1	0.45 to 0.52	Coastal studies, Soil / Vegetation recognitation.
	2	0.52 to 0.59	Vegetation vigor, Bathymetry in shallow waters, Rock/Soil recog-nation.
	3	0.62 to 0.68	Discrimination of plant species.
	4	0.77 to 0.86	Delineation of water bodies, Landforms, Geomorphic features

TABLE NO. 2.3 : REMOTELY SENSED DATA USED

IMAGERY IRS-IA

Sensor	:	LISS - II
Path / Row	:	29 / 54
Sub-scene	:	B - 1
Date of pass	:	5th February 1991 (Processed 7th February 1992)
Band	:	2
Longitudes	:	75° 18' E to 75° 29' E
Latitudes	:	20° 15' N to 20° 24' N
Maximum cloud cover	:	10 %
Scale	:	1 : 125,000

DIGITAL DATA (Floppy)

Sensor	:	LISS II
Path	:	29
Row	:	54
Date of pass	:	5th February 1991
Bands	:	1, 2, 3 and 4
Scale	:	1 : 250,000

observation of several basic characteristic features which appear on images, known as elements of photo recognition. These include tone, texture, shape, size, patterns, shadows and associations (Luder (1959), Lillesand and Kiefer(1987), Sabins(1987), Drury(1987). Generally tone, relief, shape and pattern are important factors useful in lithological interpretation, while relief, shape, lineaments, drainage etc factors are important for geomorphological interpretation. Such analysis of satellite image is useful in preparing regional scale maps of structural, geomorphological and lithological aspects.

2.5.2 Digital Data Analysis :

Remotely sensed data is recorded in digital form, which is processed by computer to produce images. Such images are easy to interprete and provide more information. The main objective of digital image processing is to make the images more readiable, so that specific information such as vegetation, water bodies, lithology and structure are extracted and high lighted by various interactive manipulations. The importance of digital image processing in the field of geology has been given by Drury (1987).

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Digital image processing methods have been grouped into three functional categories namely image restoration, image enhancement and information extraction,(Sabins, 1987). Mather(1987) described digital image processing methods into four groups viz. Image Enhancement, Image Transforms, Filtering Techniques and Classification.

2.5 -2.1 System and Digital Data Used

UIPS-32 image processing system configured around VAX 11/780 computer system has been used for digital analysis at RRSSC, Banglore. Image work is carried out on the pericolour 2000 and hard copies are taken with Dunn Camera attachment. A floppy of IRS-1, LISS-II of four bands with pixels 512 X 512 has been used for the digital analysis of the area under study.

LISS-II image constitute of tiny equal areas called as picture elements(pixels). These are arranged in rows (lines) and columns. The position of each pixel is determined on X-Y coordinate system, which originate at the left corner of the image, the pixel values are in form of number known as digital number (DN). These digital number indicates the intensity of electromagnetic energy measured for the

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respective ground resolution cell. DN values of IRS image ranges from 0 to 127 on grey scale. The intensity which represent relative brightness zero DN value is for the darkest object eg. water bodies, while 127DN value for the brightest object. The ground resolution cell of LISS-II of IRS-1A is 36.5 X 36.5 Sq.Mtrs. L ISS-II image consist of 2400 scanlines and each scanline consist of 2048 pixels. This data is recorded on seven-bit scale (i.e. 2^7=128 value from 0 to 127).

2.5 -2.2 Digital Image Analysis Methods Used:

The digital image processing techniques adopted for analysis are image enhancement liner contrast stretch and linearly stretched FCC.

Image enhancement involves the modification of an original image into modified image to improve the contrast. These methods alters the original image into a new image which is more clear in some aspectsof our interest. Generally this method is applied to the digital data of single band. The main digital image enhancement method used is contrast enhancement.

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CONTRAST ENHANCEMENT:

The sensor are designed to record a wide range of electromagnetic energy, but each scne did not use full sensitivity range of the sensors, resulting into poor images. T o know whether typical scene has utilized the entire sensitivity of the sensors, the DN values are either represented by a histogram of cumulative histogram. Histogram is a way of expressing the frequency of pixel occurrance. DN values in a data set are plotted in a series of equal ranges of bins. The height of each bin representing the frequency at which DN values in the data set fall within the chosen range. The histogram interpretes the distribution of most of the DN frequency of the available brightness range and indicates the image contrast. The most common contrast enhancement methods are 1)linear contrast stretch and 2)non-linear contrast stretch. In present study the linear contrast stretch method has been used.

LINEAR CONTRAST STRETCH :

It is the simplest method of contrast enhancement in which DN values of low and high end are assigned respectively.

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The remaining pixel values are spread linearly between these two extremes. By this method original brightness of the image is improved. This improved image is useful in the enhancement of topography, lineament, drainage and lithounit(Patil, 1992).

FCC OF LINEARLY CONTRATCH STRETCH :

Linearly stretched bands in any combination may be displayed to produce false composite image (FCC). Such FCC image provide better information regarding land forms, lineaments, water bodies and lithounits.

2.6 VISUAL INTERPRETATION OF IRS-1A IMAGE :

These investigations include interpretation of IRS-1A LISS-II band 2, image of Scale 1:125,000. The elements of photo-recognition are adopted to identify, distinguish and demarcate different features appearing on the black and white IRS image. Visual interpretation helped to recognise and prepare regional maps of lineament and gemorphology.

2.6 -1 Lineament Analysis :

Lineaments are straight or curved mappable linear features that generally represent the weak surfaces within the crust. Hobb defined lineaments are the architecture of

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the rock basement. According to O'Leary et al(1976) lineament is a mappable simple or composite linear feature of a surface whose parts aline in a straight or slightly curving relationship which differ distinctly from the paterns of adjecent features. Lineaments are recognised with feature as straight river or stream, concentration of vegetation along a straight line, topographic contrast along a straight line, tonal difference or some other discerete geomorphic feature (Washington (1984), Sabins (1987)). Simple lineaments are formed by single feature such as a linear stream and which are relatively short, perhaps 2 Kms.long. Composite lineaments consist of more than one type of feature such as combination of alined tonal features, stream segment, ridge which can be traced for hundreds of kilometers (O'Leary et al 1976).

The examination of lineaments on the IRS-1A, LISS-II, band 2 image, indicated two types of lineaments, (1)stream controlled lineaments and (2)topographic scraps(Fig. 2.1).

1) Stream Controlled Lineaments :

These are recognised easily by straight stream course and dark tone along the same. The lineaments runs for

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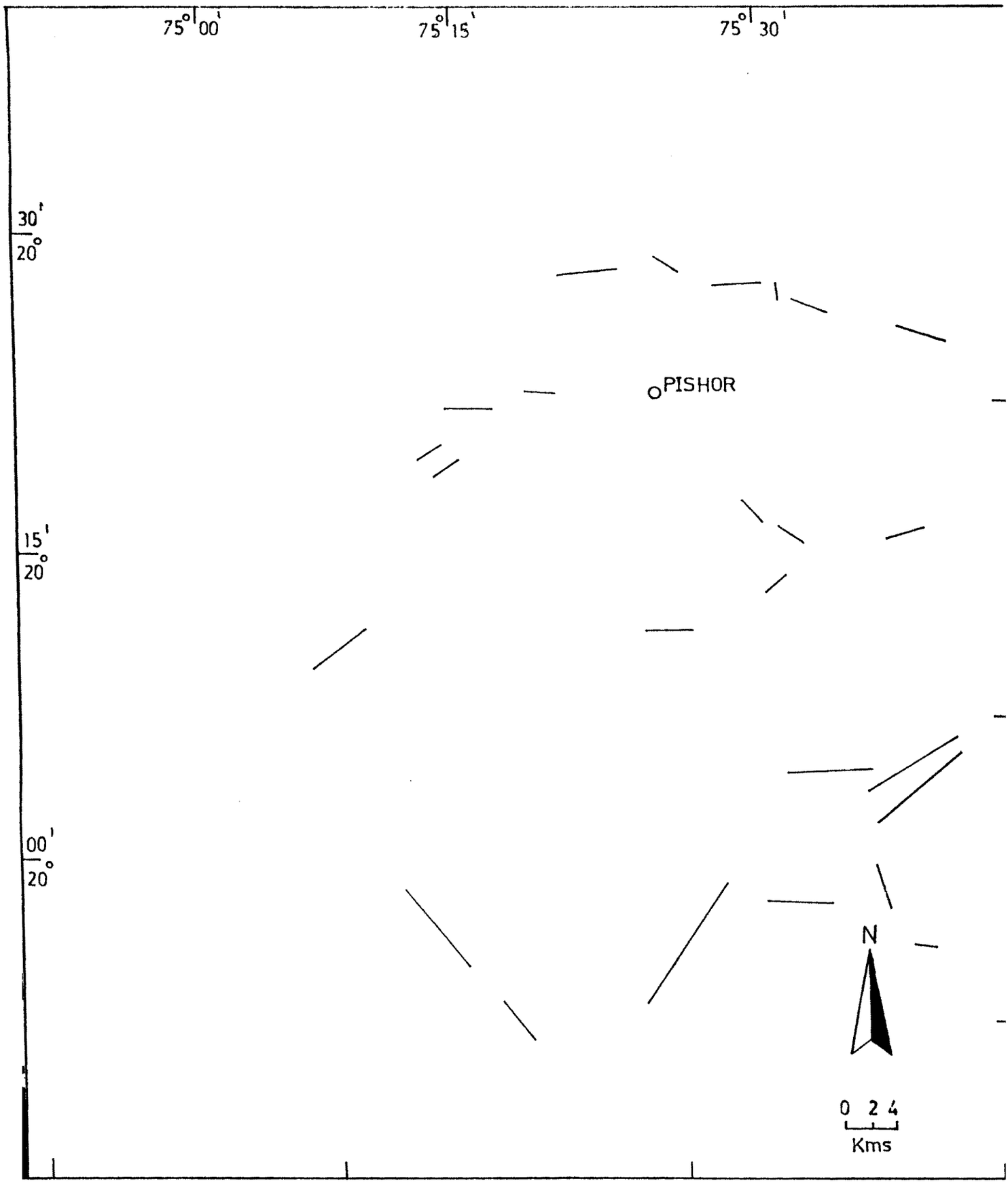

FIG. NO. 2.1 : MAP SHOWING LINEAMENTS FROM SATELLITE IMAGERY AROUND PISHOR (Scale 1:125,000).

difference of 1.0 Kms. to 8.0 Kms. These are common lineaments on the image and represent fracture in the area.

2) Topographic scrap lineaments :

These are less common type of lineaments but comparatively of more length which run 1.60 Kms. to 6.24Kms. These are identified by tonal contrast and topographic contrast along a line. These may represent master fracture in the area.

Rose Diagram :

The lineament data presented (table 2.4) in the map fig 2.1 is plotted in the rose diagram (fig. 2.2). The trend of most common lineament studied is WNW-ESE.

2.6 -2 Geomorphologic Analysis of IRS Image :

The geomorphological map presented in Fig. 2.3 was prepared by examining and recognising various features on the IRS image. These features include mesa and butte, ridge, escarpment, denudational hills, lineament, river and stream, reservoir etc. All these features are seen on the part of

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Table No. 2.4 LINEAMENT ANALYSIS DATA

Trends measured	No. of lineaments	% of lineaments	length of lineaments	length %
N 0° to 15° E	-	-	-	-
N 15°Eto 30° E	1	4	8.46	11.58
N 30°Eto 45° E	-	-	-	-
N 45°E to N60°E	3	12	9.28	12.70
N 60°E to N75°E	3	12	8.52	11.66
N 75°E to N90°E	3	12	7.44	10.18
North to 15°W	2	8	3.60	4.92
N 15°W to N30°W	2	8	8.00	10.95
N 30°W to N45°W	1	4	1.90	2.60
N 45°W to N60°W	2	8	4.96	6.79
N 60°W to N75°W	2	8	4.72	6.46
N 75°W to N90°W	6	24	16.16	22.12

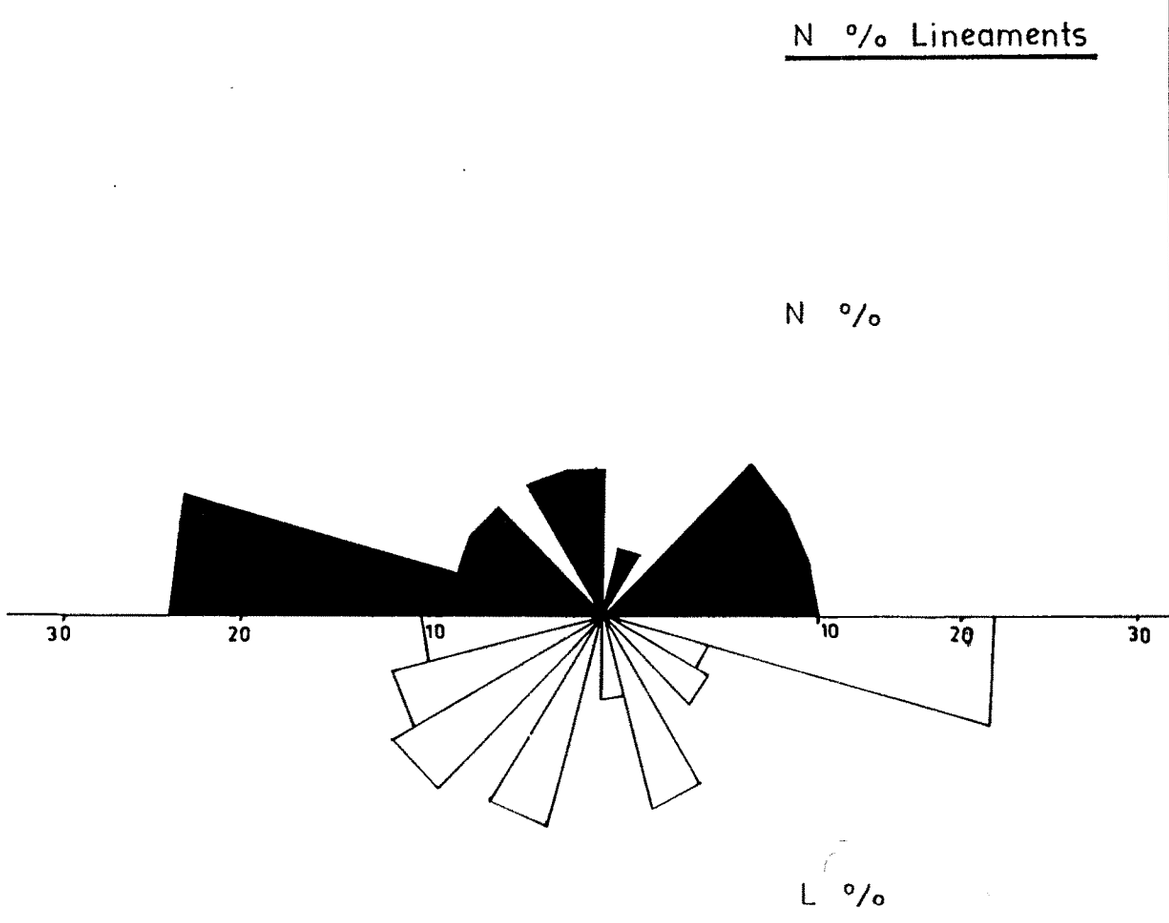

Fig. 2.2 : Rose Diagram Of Lineaments.

(Base IRS - 1A Image, Scale 1 : 125000)

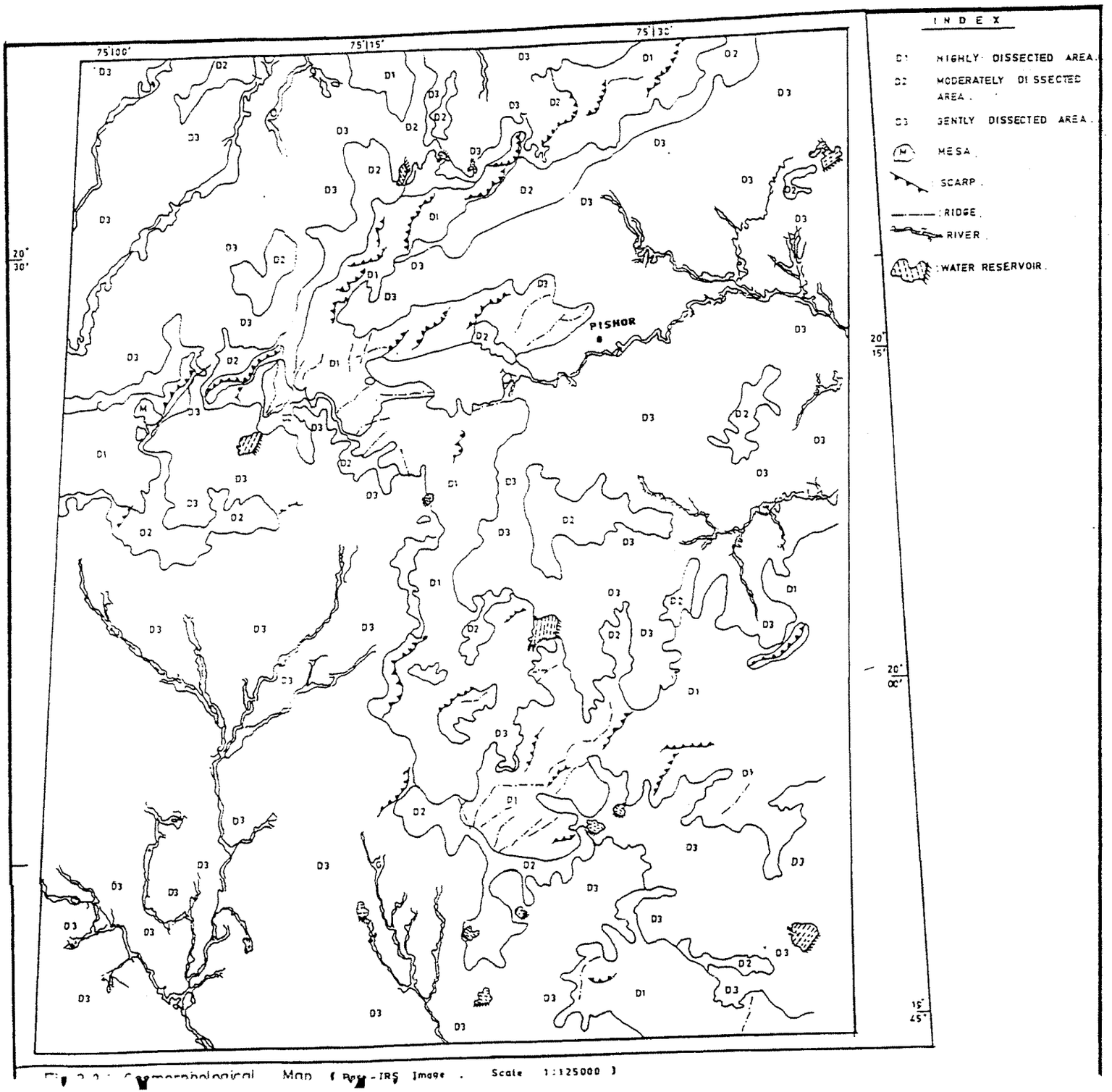

Fig 3.2.1 : Geomorphological Map (Post-IRS Image . Scale 1:125000)

Deccan Trap dissected plateau. The image characteristic features of these geomorphic units are given below-

1. Ridges :

These are the prominant physiographic features seen on the image. Two types of ridges have been recognised in the area - a)Major ridges and b) Minor ridges.

a) Major Ridges:

These ridges seperate major rivers such as Purna and Anjan. These are irregular and at some places are associated with topographic scarps, where the image show darker tone. These ridge lines represent higher altitude areas which represents, the basin boundary of the respective rivers.

b) Minor Ridges :

There are number of minor ridges which appear as irregular lines seperates the streams. These irregularities appear as comparatively light tone.

2. Hills :

Rivers, streams and gullies dissected the area to form hills and vallies. Hills have been categorised into two types a)Highly dissected hilly areas. b)Moderately dissected

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hilly areas.

a)Highly dissected areas:

This constitute highly carved part of high grounds alonowith landforms as mesa, butte, topographic scarps etc. are seen. Thus these appear as Humosky topography with uneven grey tone.

b)Moderately dissected areas:

These generally occurs as undulating moderately elevated areas in between the smaller streams. These are of comparatively lighter greyy tone. Some areas of this subunit are under cultivation.

3) Mesa :

These are the flat topped, smaller landforms which are eighter isolated or spaced along irregular ridge line. Aerialy these are irregularly elongated to triangular in shape. The sides of these geomorphic units are steep to moderately sloping along which contacts of lava flows are seen. The top of the mesas are seen with uniform grey tone while slopes are either lighter grey or with bands of varying grey

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tone. The top of the mesas at some places show mottled texture, this is because of occurance of agricultural fields.

4) Gently dissected areas:

These are low lying areas and seen on either side of the river courses. Mostly these are plain areas and under cultivations, thus typically show agricultural field patterns.

5) Lineaments :

As described in the previous section 2.6.1, these are linear fractures mainly controlled by stream which represent fractures.

6) River or Stream :

These represents network of drainage. The major rivers in the study area are Purna and Anjan. The courses appear as thick brighter, wavy lines. Bright tone is due to sandy deposits in their courses. Streams are of varying length and generally recognised by dark lines. Such dark lines are due to the luxurous growth of vegetation along the streams.

7) Reservoir :

Image display few smooth & dark tone areas across some river or stream which are the reservoirs in the area.

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2.7 DIGITAL IMAGE ANALYSIS OF IRS-1A :

The IRS-1A, LISS-II, digital data of bands 1,2,3 and 4 of 5th February 1991 in BIL format has been used for the study. A floppy of 512 pixel X 512 pixel with an area of 18.56 X 18.56 Sq.Kms. around Pishor was selected to carry out digital analysis. Two types of operations have been carried out to acq uire image prints (1)Linear stretched bands of 1,2,3 and 4 each (Plate 2.1 to 2.4) & (2)Linear stretch FCC of bands 2,3 and 4 (Plate 2.5).

The utility of these images is mentioned in table 2.5. The linear stretched operations of four bands indicate that, comparatively linear stretched band 2 provides better details than other bands (Table 2.5). Linearly stretched FCC of bands 2,3 and 4 gives excellent results of various features of the study area.

LINEARLY STRETCHED IMAGES :

By studying linearly stretched images(Plate 2.1 to 2.4) indicate that the physiography landforms, vegetation as well as lava flows can easily be distinguished on the bands of 1,2 and 3 while linearly stretched band 4 display

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TABLE NO. 2.5 : UTILITY OF COMPUTER PROCESSED IMAGES SHOWING GEOMORPHIC FEATURES

Bands 1, 2, 3, 4 and FCC (2, 3, 4)

Terrain features	Linearly stretched bands				
	1	2	3	4	FCC
Mesa/Butte	Good	Good	Good	Fair	**Excellent**
Valley slope	Good	Good	Good	Poor	**Excellent**
Drainage	Good	Good	Fair	Poor	Good
Vegetation/ Agriculture	Good	Fair	Good	Poor	Excellent
Water bodies	Fair	Fair	Good	Excellent	Excellent
Basaltic lava flows and Red beds	Fair	Good	Fair	Poor	**Excellent**

poor topography, vegetation etc., but water bodies are marked distinctly. Lava flows are distinguished on the bands 1,2 and 3 on images along topographic scarps of ridge or mesas in the form of alternate bands of dark and grey tones. Such lava flows are not recognised on the band 4. Vegetation in the case of 1,2 and 3 bands appear as grey to dark grey tone, while on the band 4 it is brighter tone.

LINEARLY STRETCHED FCC :

This image (Plate 2.5) display excellent false colours which are useful in distinguishing topography, landforms, vegetations, lineaments, water bodies, and lava flows. Vegetation is displayed as dark red specially in the low area and on either side of river, which represent agricultural fields. Topography with highly dissected and moderately dissected areas are recognisable easily. Higher dissected areas show two types of landforms as mesa & ridge. The outcrops of mesa are narrow and elongated or triangular in shape, with bluish grey colour. Three lava flow units are readily distinguishabl e mainly along the topographic scarp and highly dissected areas. The seperation of lava flows is possible with the red coloured band, this red bands represent

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red beds in between the lava flows. The lava flows appear as bluish white to white in colour. Water bodies (reservoir) appear blue or dark blue colours, while rivers, courses appear as white brighter in colour. In general most of the geomorphic features and lava flows are very well exhibited on the FCC. After studying linearly stretched FCC image geomorphological map (Fig. 2.4) and lithological map (Fig. 2.5) are prepared.

2.8 UNRECOGNISED FEATURE :

It is interesting to note that a single feature which is nearly west of Pishor was unrecognised on the digitaly analysed images. This feature is a linear brighter feature which is short in length occur across the Anjan river(plate 2.1 to 2.4) and was not seen on the air photographs. This feature is very distinctly seen on the linearly stretched FCC image (Plate 2.5). This feature may be possibly a bridge.

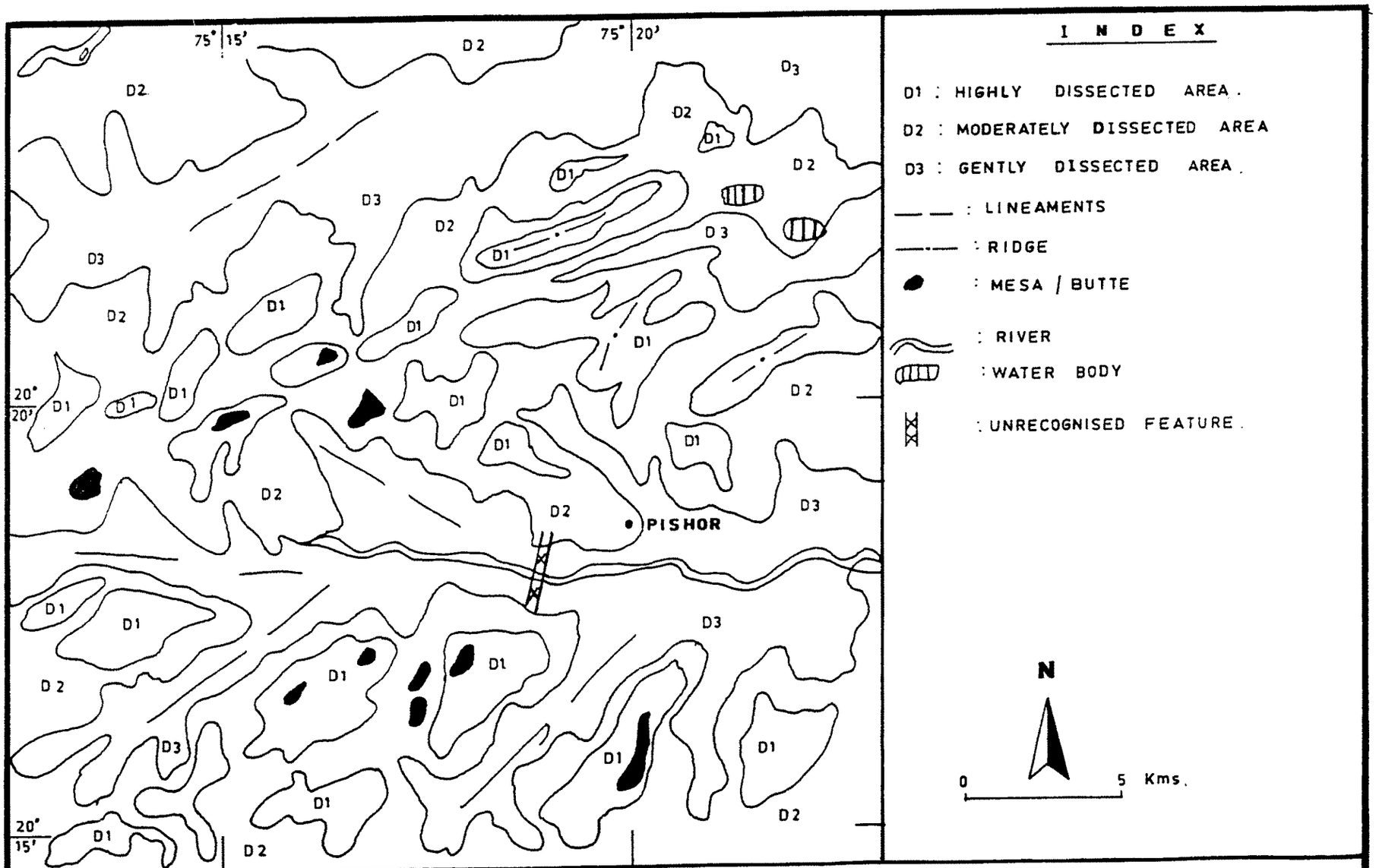

Fig. 2·4 Geomorphological Map. (Base - Digital Data , Scale 1 : 250000) .

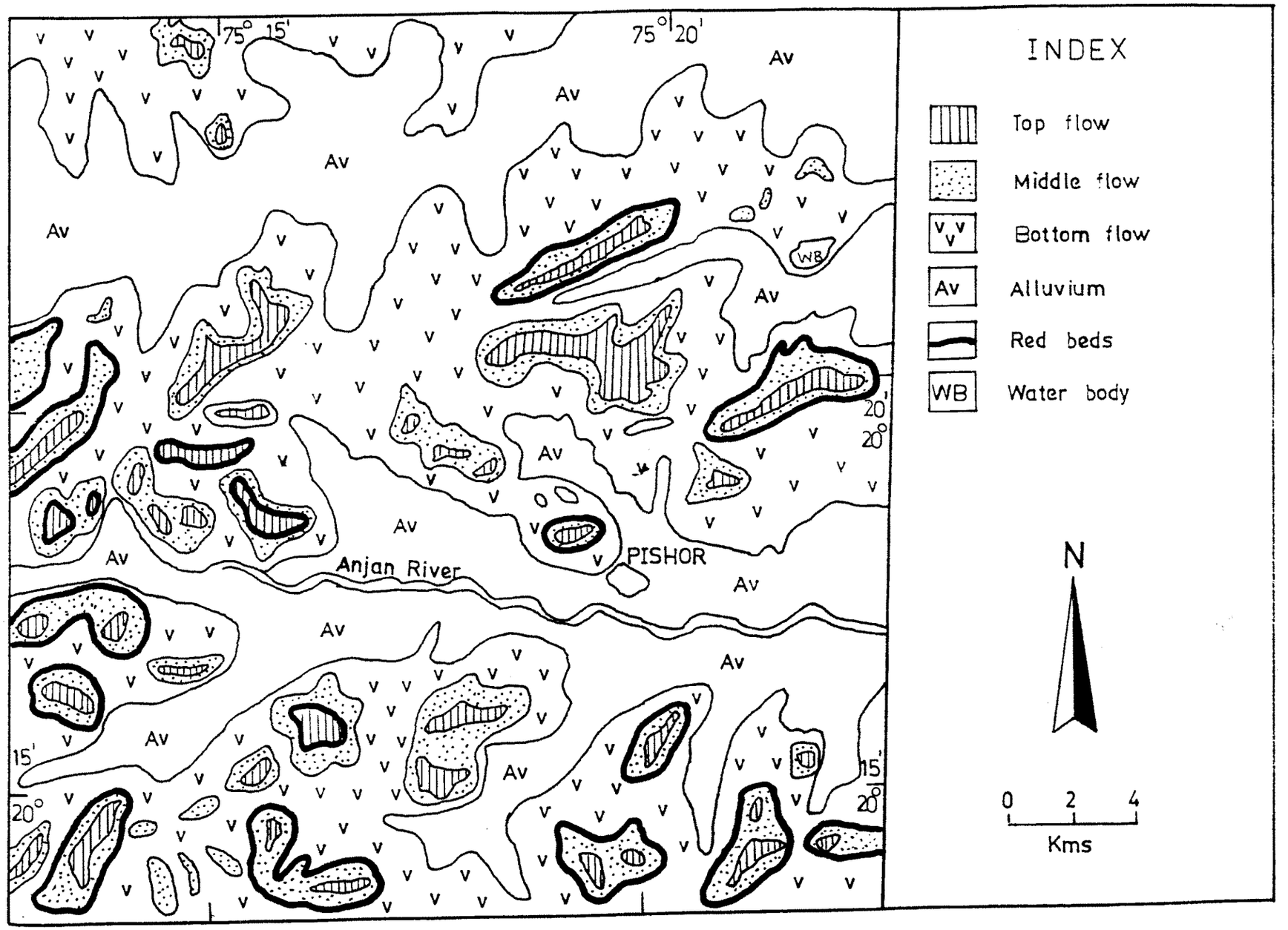

FIG. NO. 2·5 : LITHOLOGICAL MAP WITH LINEARLY STRETCHED FCC.