GEOLOGICAL INTERPRETATION OF BHASKARA-II (I.S.R.O.) IMAGERIES : A COMPARATIVE STUDY OF THE RESULTS USING LANDSAT IMAGERIES AND AERIAL PHOTOGRAPHS

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ABSTRACT

Geological interpretations were carried out in a part of south India to evaluate the efficacy of the BHASKARA-II two-band imageries on a 1:2 M scale, vis-a-vis the conventional multiband LANDSAT imageries and panchromatic aerial photographs. The area studied is underlain by the Archaean metamorphics, late Proterozoic Kaladgi and Bhima Groups of sediments and the Cretaceous-Tertiary Deccan Trap basaltic lavas. This comparative study revealed the following potential of the BHASKARA-II imageries :

(a) Regional geological mapping/discrimination of the various major units was possible.

(b) Major lineaments representing faults and fracture zones could be delineated. The low resolution of the BHASKARA-II imageries was found to be useful in marking some of the lineaments (viz : Saundatti lineament) which are otherwise not notable in the conventional aerospace imageries.

1.0 INTRODUCTION

1.1 BHASKARA-II is India's second experimental satellite for conducting earth resources surveys. It was launched on 20th November 1981. The satellite is equipped with two primary payloads for earth observations (the details of these are given in TABLE : 1) namely,

(a) a 2-Band Television camera system, (for collecting land imageries and

(b) SAMIR, a microwave Radiometer, (for conducting ocean--surface studies).

The TV camera system had to be shut down after two months of operation due to a technical snag which developed in the

TABLE : 1

BASIC CHARACTERS OF BHASKARA-II AND ITS PRIMARY PAYLOADS

PARAMETERS OF BHASKARA-II SATELLITE

(i)	Overall height (inclusive of antenna)	:	1559 mm
(ii)	Distance between nozzle-axes	:	1900 mm
(iii)	Distance between diametrically opposite corners of the deck plate	:	1560 mm
(iv)	Total surface area covered by solar cells	:	37,280 cm^2
(v)	Weight	:	436 kg

SPECIFICATIONS OF THE PRIMARY PAYLOADS

A. TWO BAND TV CAMERA SYSTEM

(i)	Camera tube	:	Slow scan vidicon coupled to image intensifier.
(ii)	Spectral Channels	:	(1) 0.54-0.66 microns (2) 0.75-0.85 microns
(iii)	Picture frame	:	341 KM x 341 KM
(iv)	Ground Resolution	:	1 KM
(v)	IF OV	:	49.37°
(vi)	Exposure Duration	:	1.0/1.5/2.0 m.sec. selectable by Ground control
(vii)	MTF throught image	:	80 % at 12 ℓp/mm 50 % at 50 ℓp/mm

B. SAMIR PAYLOAD

(i)	Frequency of Operations	:	19.35, 22.235 and 31.4 GHz
(ii)	No.of horns	:	3
(iii)	Antenna beam width	:	14° (3 db)
(iv)	Swath	:	125 km
(v)	Integration time	:	300 m.sec.
(vi)	Resolution	:	Better than 1° K
(vii)	Range	:	40° K to 320° K

system. Till its date of shutting down, it had collected and transmitted 550 multiband imageries and 1278 near I.R. imageries of the Indian subcontinent. (Katti, (in SAC, ISRO) 1982). The SAMIR data was being recorded during the 3990 orbits the satellite completed till 10 August 1982. After this the satellite system was put on an alternative mode of operations to carry out certain other operations, and experiments.

1.2 The TV camera system consisted of two cameras operating in the visible (Band 1) and the near I.R. (Band 2) regions which recorded images within the wavelength ranges of 0.54 - 0.66 microns and 0.75 - 0.85 microns respectively. Each camera was made up of a slow scan image-coder coupled to an image intensifer. From the satellite altitude of 525 kms, the camera focused on an area of roughly 341 x 341 kms^2, in each exposure. The resolution of the system at that altitude was of the order of 1 km x 1 km for each PIXEL. The data transmitted from this system was processed and standard imageries were prepared by I.S.R.O. on a scale of roughly 1:2 M as BW paper prints.

The user agencies involved in the "Respond programme of ISRO" were sent these imageries for their critical evaluation in different aspects of applications. The main areas of application identified by ISRO were :

(a) Landcover and land-use pattern studies
(b) Vegetational/ crop-studies
(c) Geology-geomorphological studies
(d) Snow-cover and hydrological studies

The comments and criticism of the user agencies, as well as the ISRO scientists were presented at a seminar-cum-workshop in October 1982, so as to gain an insight of the actual capabilities. Further studies were envisaged, with a view of identifying the exact capabilities and shortcomings in this experimental system, so that the forthcoming Indian Remote Sensing Satellite (IRS-proposed to launch in 1985) may become a fully operational system, capable of transmitting near-real time earth-observation data.

1.3 The present investigations form a part of this evaluatory study, to establish the capabilities and shortcomings of the two-band BHASKARA T.V. imageries vis-a-vis their applications in geological investigations.

2.0 THE STUDY

2.1 Established methods of remote sensing, in geology, such as the multiband LANDSAT imageries and panchromatic aerial photographs were used as reference material in this capability study. A comparative study of the information yielded by the various sensory-data outputs was carried out by visual interpretation. The materials used in this investigation were as follows :

(a) BHASKARA imageries : Bulk processed B.W. paper prints

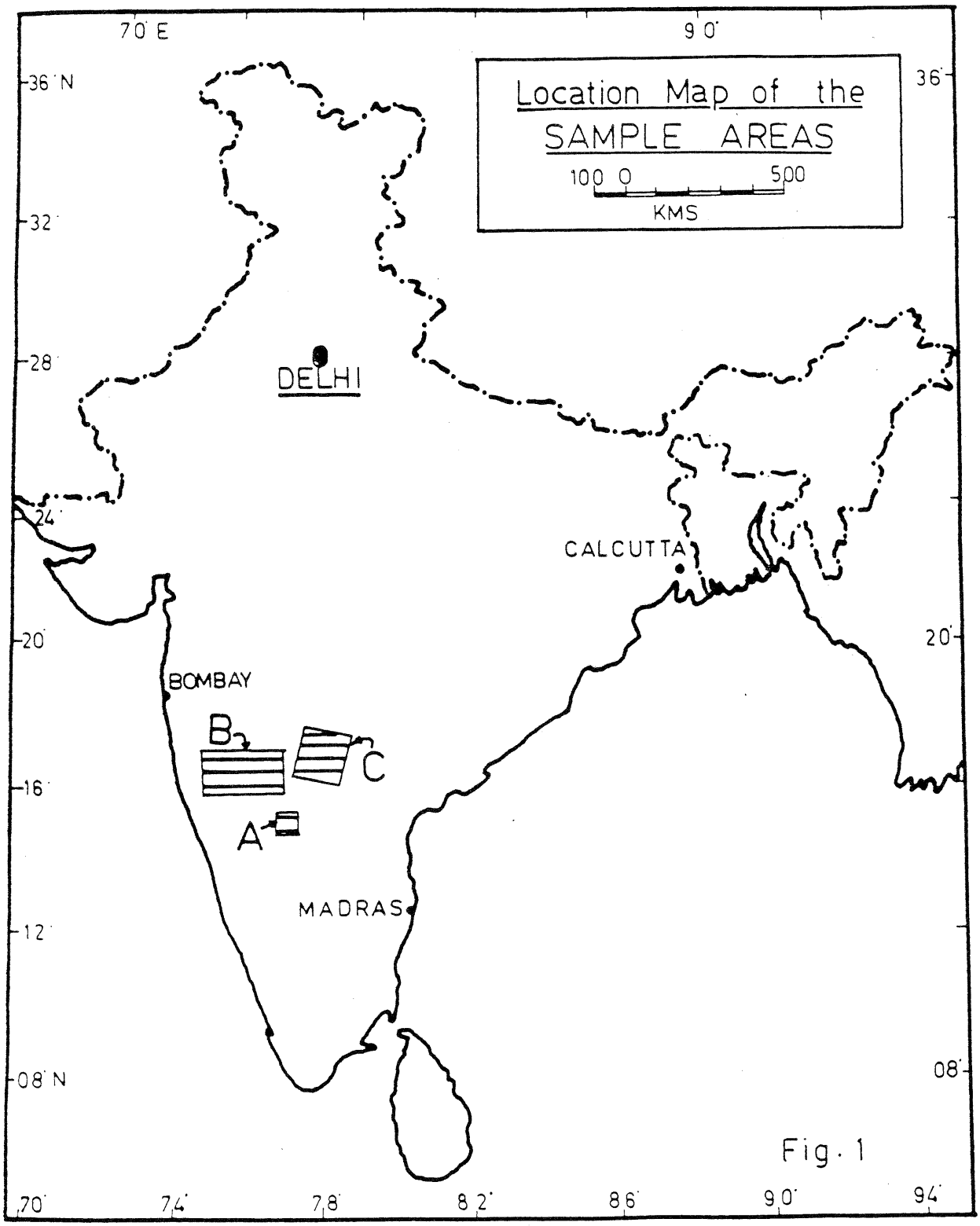

70 E
90
36 N
36
32
28
24
20
16
12
08 N
08
Location Map of the
SAMPLE AREAS
100 0 500
KMS
DELHI
CALCUTTA
BOMBAY
B
C
A
MADRAS
70
74
78
82
86
90
94

Fig. 1

of imageries of the T.V.system in Bands 1 (wavelength range 0.54 microns - 0.66 microns) and 2 (wavelength range 0.75 microns - 0.85 microns) on a 1:2 M scale, in the standard 17 cm x 17 cm format.

(b) LANDSAT imageries : B.W. paper prints of Bands V (wavelength range 0.6 microns - 0.7 microns) and VII (wavelength range 0.8 microns - 1.1 microns) on a 1:1 M scale. These bands were chosen as they closely match with Band 1 (visible) and 2 (near I.R.) respectively of the BHASKARA imageries.

(c) Aerial photographs : Panchromatic black and white aerial photographs on a 1:60,000 scale.

Local geological information has been collected from the published maps by the Geological Survey of India, as well as the from the field mapping carried out by this Department under I.S.R.O. sponsored schemes.

2.2. FIG. 1. shows the locations of the various parts of India which were studied during this evaluation. The choice of the areas was partly determined by the availability of the aerospace imageries for evaluation and partly by their being presently under investigation by this department.

Right at the outset of this investigation, it was realised that comparison with aerial photographs of the BHASKARA imageries would not be strictly valid, due to the inherent operational differences between them. However aerial photographs were found useful as back-up information where the delineation of boundaries was problematic, or, where local geological information was required.

The visual interpretation of the BHASKARA imageries yielded a fairly good amount of comparable information. Table 2 gives the spectral response characters in the different bands of the different lithostratigraphic units in Sample Areas A, B and C respectively, as found in both the BHASKARA and LANDSAT imageries.

Fig. 2, 3 and 4 are the geological interpretation maps prepared from these imageries for the three sample areas, A, B and C respectively.

2.3 RESULTS

The main results of the study of the BHASKARA imageries may be enumerated as follows :

(a) In all the three sample areas, the major lithostratigraphic units could be separated from each other on the basis of their tonal and textural characters. It was however almost impossible to distinguish between the Quaternary Laterites and Deccan Trap Basalts in sample area 'C' (Fig. 4). Also, distinction between the Kaladgis and Dharwars in sample area 'B' was a bit difficult, due to their closely matching tonal

TABLE 2 : PHOTORECOGNITION CHARACTERS AS SEEN IN SATELLITE IMAGERIES

LITHOSTRATIGRAPHIC UNITS	BHASKARA COVERAGE				LANDSAT COVERAGE			
	Band 1		Band 2		Band V		Band VII	
	Tone	Texture	Tone	Texture	Tone	Texture	Tone	Texture
7 Quaternary Laterites	Light to medium Grey	Fine, Smooth to uneven	Medium Grey	Coarse, uneven	Medium Grey	Coarse, uneven	Dark Grey	Coarse, Smooth
6 Deccan Trap Basalts					Variable in shades of Grey	Coarse, uneven	Medium to dark Grey	Variable
5 Bhima Group	Medium Grey	Fine	Dark Grey	Coarse, uneven	Dark Grey	Fine to medium	Medium Grey	Fine to medium
4 Clospet Granites	Medium Grey	Fine uneven	Dark	Fine	Light Grey	Coarse, uneven	Light to medium Grey	Fine
3 Kaladgi Supergroup	Medium Grey *	Fine, uneven	Light Grey to very light *	Smooth	Medium Grey *	Smooth	Medium Grey *	Smooth to uneven, coarse
2 Dharwar Metasediments	Medium Grey to Dark Black	Fine, even to uneven	Light to dark Grey	Smooth, coarse	Variable	Fine, even	Variable in shades of Grey	Smooth to uneven coarse
1 Peninsular Gneissic Complex	Variable	Coarse, even	Medium to Dark Grey	Smooth fine	Variable	Variable	Medium to light	Smooth, fine or Granular

* Quartzite ridges appear as light toned linear bands.

Fig. 2 SAMPLE AREA : A

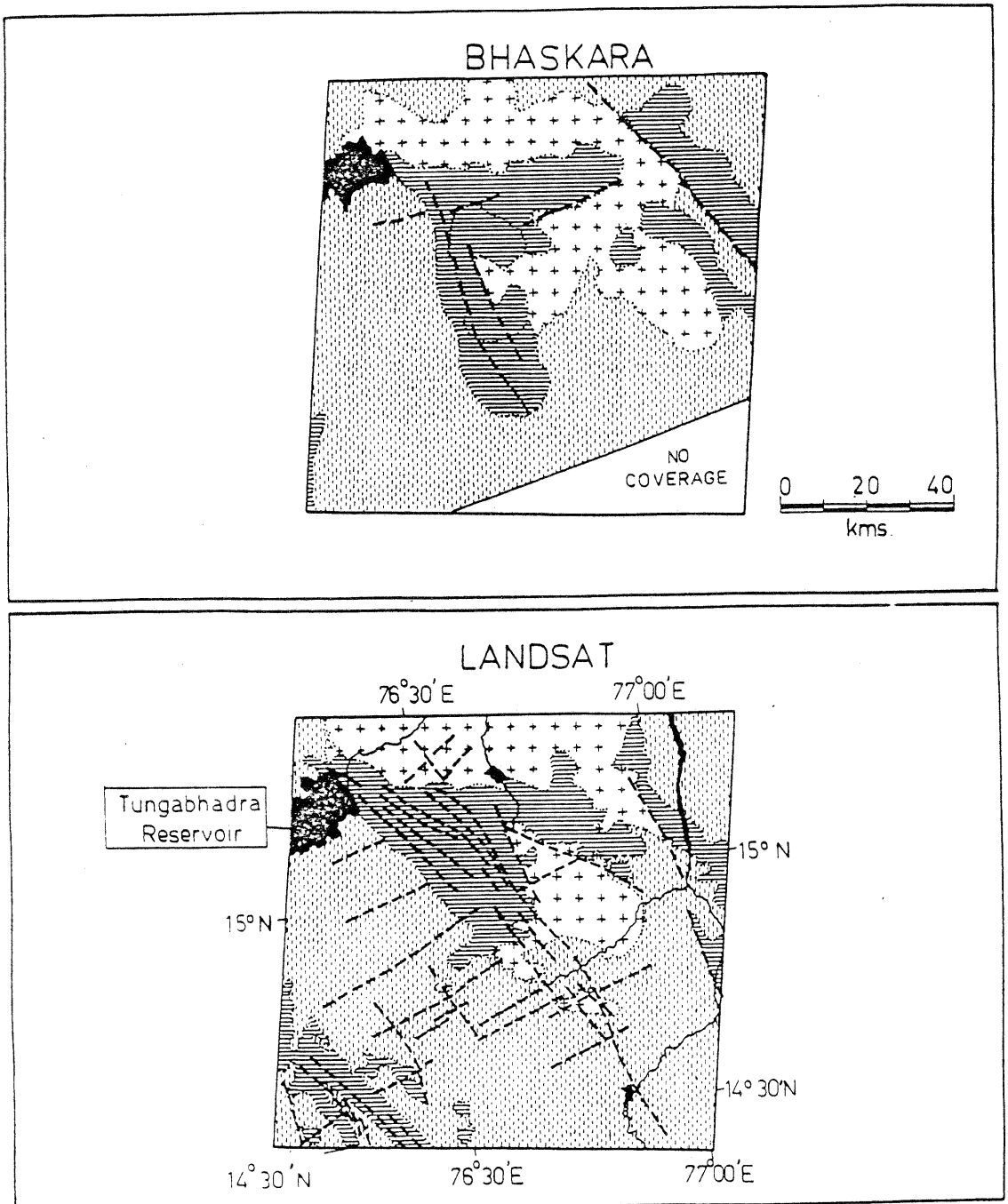


Fig. 3

SAMPLE AREA : B

INDEX

- RESERVOIRS / RIVERS
- LINEAMENTS
- STRIKE RIDGES
- DECCAN TRAPS
- BHIMA GROUP
- KALADGI SUPERGROUP
- DHARWARS
- P. GN. COMPLEX

BHASKARA

0 20 6,0
kms.

LANDSAT

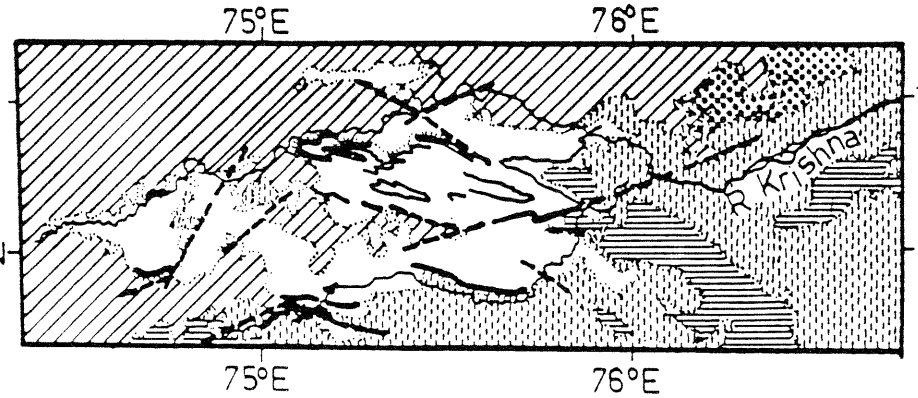
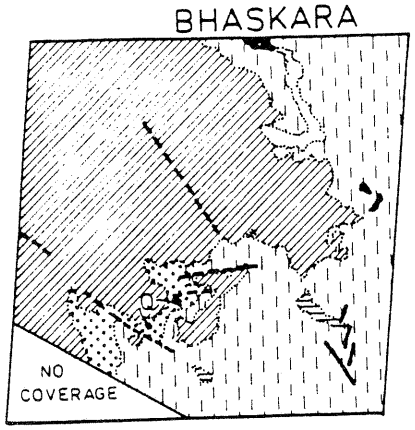
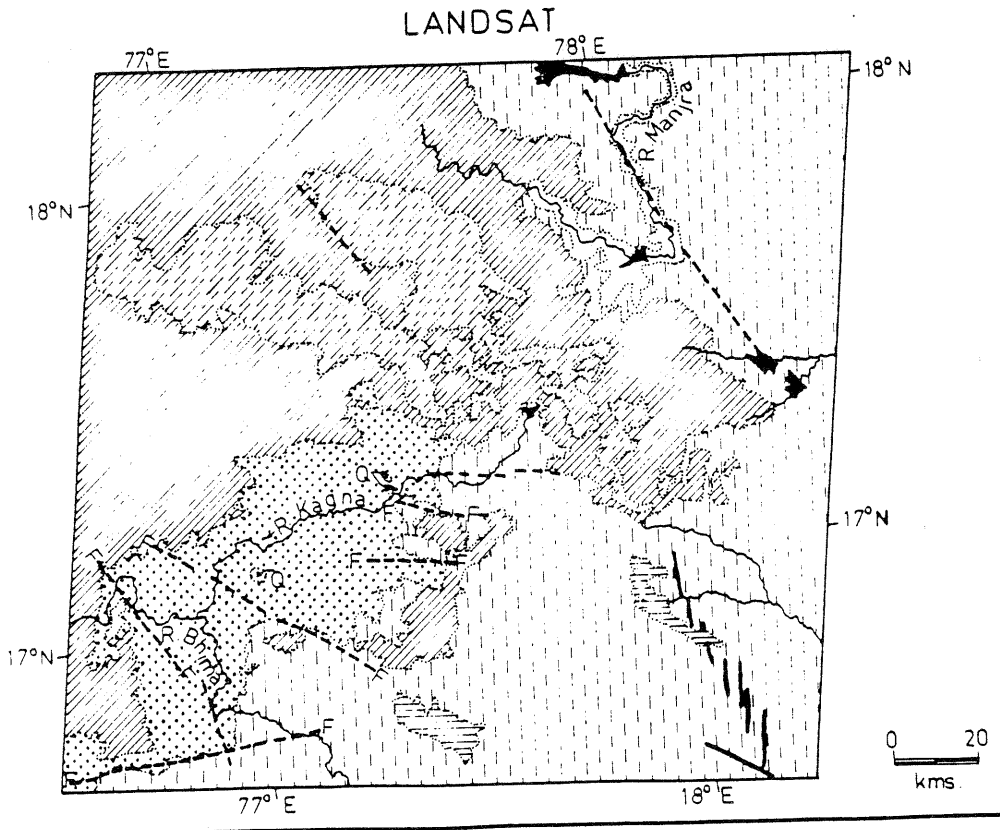


Fig. 4 SAMPLE AREA : C

NOTE -
QUATERNARY LATERITES CANNOT BE SAPERATED FROM DECCAN TRAPS





INDEX

- RIVERS / RESERVOIRS
- RIVER-BED GRAVELS
- LINEAMENTS
- DYKES / FAULTS
- QUARRIES

- QUATERNARY LATERITES
- DECCAN TRAPS
- BHIMA GROUP
- DHARWARS.
- P. GN. COMPLEX

characters.

(b) Whereas LANDSAT imageries allow some extent of lithological separability, such a distinction is not possible in the case of the BHASKARA imageries. The only exceptional case was that of the folded quartzite ridges of the Kaladgis (around Lokapur) which could be roughly identified. The utility of aerial photographs far surpasses both of these in lithological separability for obvious reasons, starting primarily with the resolution factor and the scale differences.

(c) The structural elements of the various lithostratigraphic units are roughly identifiable in the BHASKARA imageries. This, however, cannot be compared with the structural data available in LANDSAT imageries as well as aerial photographs. However, as in Fig. 4 some of the major lineaments could be extended longer in the BHASKARA imageries than their extents observed in the LANDSAT imageries. Also, the Saundatti lineament which represents a fault (Fig. 3) could be delineated more sharply in the BHASKARA imageries.

(d) One observation made during this study needs special notice. In the sample area C (Fig. 4) a distinct light toned patch was found representing the limestone quarries around Wadi in Karnataka State. This quarrying activity has laid bare fresh rock surfaces which naturally have a higher reflectance than the surrounding vegetated limestone country.

(e) Whereas the geometric accuracy of the maps drawn from the BHASKARA imageries leaves much to be said, the positional accuracy of the various features in these imageries is only approximate. This also has yielded large distortions in the size and patterns of the outcrops of various lithostratigraphic units. This is evident from the Figs. 2,3 and 4.

3.0 CONCLUSIONS

3.1 The utility of the aerial photographs as well as the multiband LANDSAT imageries for geological mapping is well established. These, therefore, provided an established standard of reference for evaluating the capabilities of the BHASKARA imageries for geological mapping.

The above results of the study show that much more detailed information is available in the established remote sensing methods than that available from the BHASKARA imageries. However, the latter do definitely have a limited utility, insofar as regional geological mapping is concerned.

3.2 This limited utility of BHASKARA imageries for geological mapping is mainly due to two main factors, namely :

(a) The very small scale of the imageries; and

(b) The very low resolution (and hence the large size of the ground resolution element for a small PIXEL) of the T.V. Camera used for scanning.

As shown above, the small scale was found to be useful for highlighting regional lineaments which were indistinct on large scales. Also, the small scale means a larger coverage in a single frame of the imageries, yielding a wider scene for study.

3.3 Lastly, it must be pointed out that the entire BHASKARA mission was an experimental prelude to the forthcoming IRS mission. In this context, the results obtained in the above study show that the indegeneous Remote Sensing capability developed for the BHASKARA mission has very encouraging outputs. With refinement in this technology and by improving upon the above mentioned shortcomings the future Indian Remote Sensing (IRS) will have truly operational capabilities, atleast comparable, if not better than these of the LANDSAT mission.

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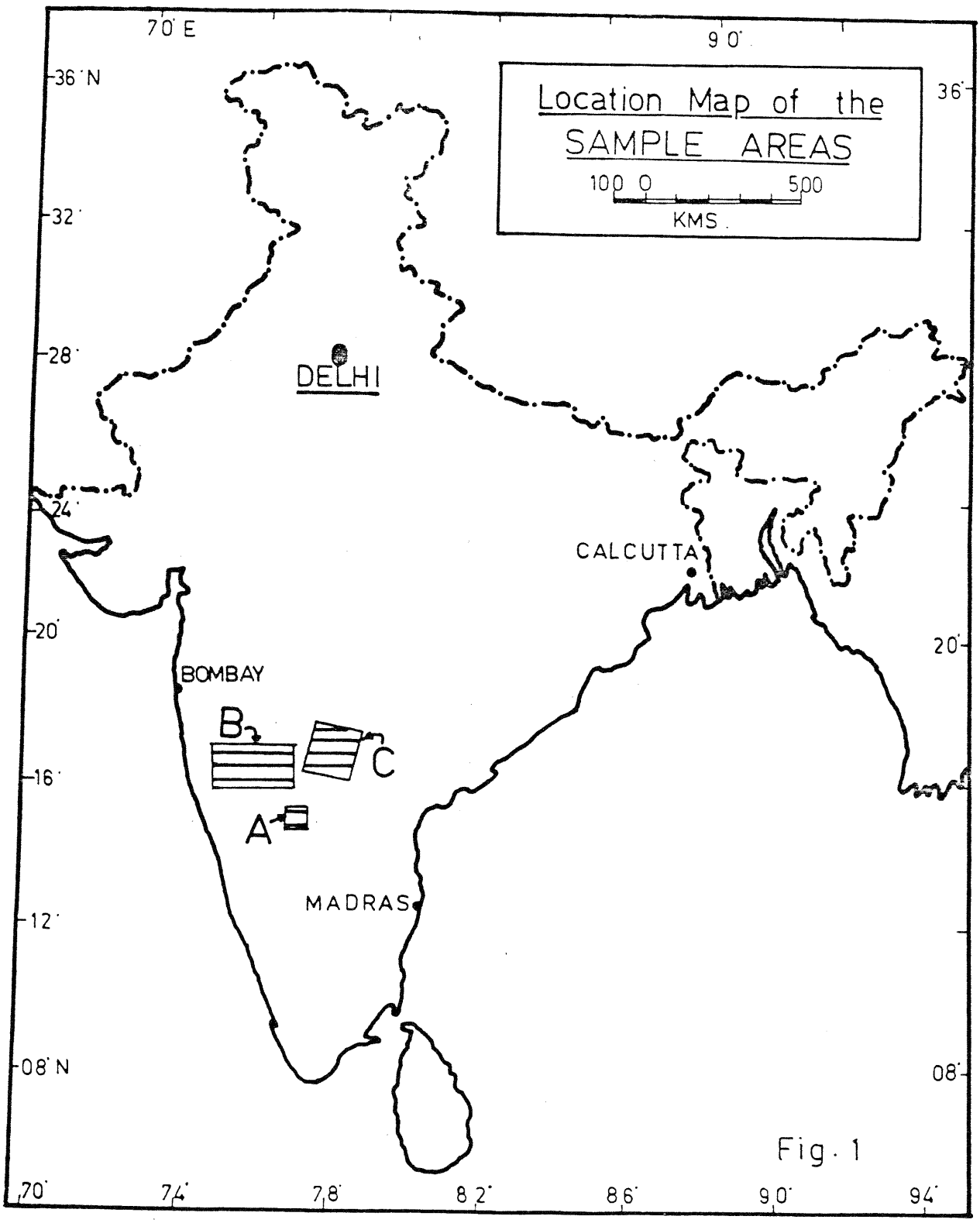
REFERENCES

SPACE APPLICATIONS CENTRE (ISRO) : (1980) Bhaskara TV Camera Data User's Guide; pp: 1-38

SPACE APPLICATIONS CENTRE (ISRO) : (1982) Proceedings of Seminar-cum-Workshop on Applications of Bhaskara-II TV and SAMIR Data;

SPACE APPLICATIONS CENTRE (ISRO) : (1982) Scientific Studies Using Bhaskara II T.V. Data


70° E
90°
36° N
32°
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24°
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16°
12°
08° N
36°
20°
08°
Location Map of the
SAMPLE AREAS
100 0 500
KMS.
DELHI
CALCUTTA
BOMBAY
B
C
A
MADRAS
70°
74°
78°
82°
86°
90°
94°

Fig. 1