

# TECTONIC STUDY AROUND INDORE (CENTRAL INDIA) WITH EMPHASIS ON SEISMOLOGY USING VISUAL & DIGITAL IMAGE PROCESSING TECHNIQUES

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## ABSTRACT

In the recent past, region in and around Indore forms one of the interesting seismic zone. In August 1982 till December 1982, about 50 shocks lasting till five seconds approximately were felt. In October 1990, similar shocks were felt but their time duration and intensity of shocks was more. Geologically, Indore is part of Deccan trap basalts having different sets of joints, additionally, 60 Kms. away from Indore river Narmada flows in a rift zone flanked with faults & fractures. Geomorphological & quaternary geological studies have indicated that the area is tectonically disturbed.

In the recent studies, the author has used Landsat TM and IRS LISS II data to prepare the lineament map using visual & digital image processing techniques. Statistical analysis has been carried out and the results have been interpreted emphasizing the tectonic origin of the structure lineaments. From the results obtained so far, it is difficult to conclude the exact cause for the origin and cause of the shock waves, but only inferences could be drawn presently. Looking to the tectonic set up, the author feels this may be due to normal faulting and fold axis which give rise to wedging under tension, as the area under study lies just above Narmada Tapti Rift and there is also Aravalli axis of folding which takes turn near the study area continue further to meet the Aravalli strike. The author is also of the opinion that such tremors may be due to slicken side effects in black cotton soil or the presence of vertical, angular, horizontal and columnar joints. The author also feels that such shocks can be attributed to volcanic phenomenon.

## KEYWORDS

TECTONIC, INDORE, SEISMOLOGY, REMOTE SENSING, STRUCTURAL ANALYSIS.

### 1. INTRODUCTION

Data on earth quake occurrence, geological and tectonic set up of the area and evidences of movements in geological recent times are utilized to identify seismotectonic lineaments capable of generating an earthquake. No unique methodology has so far been evolved to account for all the uncertainties in geological data for estimating earthquake probabilities and evaluation of seismic risk for practical applications. Greater reliance is thus made on earthquake occurrence and strong ground motion records for prediction of ground motion with the assumption that same pattern of earthquake will be valid for the future. In case some seismological data is meagre or not available, extrapolation of information from regions of past earthquake to potential source of regions in the vicinity of the site is attempted for the evaluation of ground motion.

On August 15, 1982, people living in Joshi Guradia situated about 18 Kms. from Indore have felt ground shocks lasting for about 2 seconds. The maximum duration of shocks was about 5 seconds. About 50 shocks were felt till December 1982. Occurrence of similar shocks was also reported at village Datoda about 5 Kms. west of Joshi Guradia. An important observation made by the author was that the Village Shiv Nagar situated 2 Kms. north of Joshi Guradia and Tinha 1 Km. south of Joshi Guradia was devoid of this activity. On October 6, 1990, occurrence of similar shocks was reported from Village Machal 20 Kms. west of Indore. Here, the intensity of shocks was more as compared to the earlier one.

### 2. OBJECTIVE

In the present study, the author has used Landsat MSS TM and IRS LISS II data to prepare the lineament maps using visual & digital image processing techniques. Statistical analysis has also been attempted and the results have been interpreted emphasizing the tectonic origin of the structural linea-

ments.

### 3. REVIEW

#### 3.1 Tectonic Evaluation in Relation to Seismology of India

The tectonic evaluation of the earth's crust in India has been done in two main stages :

- i. Geosynclinal stage.
- ii. Platform stage.

#### 3.2 Geosynclinal Stage

Tectonic classification of a territory by the age of main folding that completes the geosynclinal development is a well known principle outlined by Argand (1924), Arkhangelokiy (1941) and Shastky (1960). Five folded regions constituting the basement of the Indian platform could be distinguished in Indian peninsula. They are five folded regions constituting the basement of Indian platform. They are :

- i. Dharwar folding.
- ii. Aravalli folding.
- iii. Eastern Ghat folding.
- iv. Satpura folding.
- v. Delhi folding (Krishnan 1953 and Narayan Swami 1966-a).

#### 3.3 Platform Stage

The platform stage of evolution begins with the consolidation of geosynclinal areas to form the basement of platform. The Indian platform is characterized by the folded basement of Archaean and Proterozoic rocks. A number of sedimentary basins forms the parts of Indian platform.

Tectonic evolution of the Indian platform has been traced through the six sedimentary covers of the platform. Each of these sequences limited by pronounced unconformities of wider extent

corresponds to a major stage in the platform evolution. These are :

- i. Neogene sequence.
- ii. Palaeogene sequence.
- iii. Mesozoic sequence.
- iv. Vindhyan sequence.
- v. Cuddapah sequence. (Map 1).

#### 4. STUDY AREA

The area under study is around Indore (Central India) having the following limits :

75° - 78°  
22° - 24°

#### 5. FEATURES OF THE STUDY AREA

Geologically, Indore is part of the Deccan trap, which is made principally of volcanic rocks of basaltic composition, which is characterized by amygdular & vesicular structures. About 60 Kms. away from Indore, river Narmada flows in a rift zone flanked with faults, folds and fractures.

##### 5.1 Tectonic Divisions

The area under Indore has relevance to the following tectonic set-up :

1. Area of Satpura folding of the Precambrian age.
2. Area of Aravalli folding at the Precambrian age.
3. Deccan synclise. } Super order structures.
4. Vindhyan synclise. }
5. Malwa ridge - first order structure.

An extensive area in the west central part of India covered by thick volcanic effusives shows regional negative anomaly. It seems to represent a major negative platform structure with appreciable thickness of Cuddapah, Vindhyan, Gondwana and mesozoic sequences are present suggesting that some of the sequences may show a basinward increase in thickness below the traps.

##### 5.2 Tectonic Evolution

The area under study is influenced by the evolution of Vindhyan sequence and igneous activity represented by the Deccan trap flows.

Extensive areas of the Indian platform underwent subsidence either overlies unconformably the Cuddapah or rests directly on the basement. The Cuddapah and the Vindhyan sequences wherever they occur together are separated by a period intensive tectonic activity resulting in a major change in the pre-existing structural pattern. The Vindhyan is much less disturbed, practically devoid of metamorphism with less frequent basic intrusives. The sequence shows extensive development to the north of Narmada fault zone in the Vindhyan synclise. The Vindhyan are considered to range in age from proterozoic to lower palaeozoic. The Vindhyan represents stable shelf sediments in the outer part changing to red sandstones towards the topmost part. The Indian platform after the close of Vindhyan sedimentation experienced position movement and remained uplifted within end of middle carboniferous.

A significant point in the evolution of Indian platform is marked by the very wide-spread igneous

activity represented by the Deccan trap lava flows covering an extensive area of the platform mostly conferred to the central & western India. The area under study is situated in this region. These represents Plateau Basalts with alternating inter-trappean sediments. The Deccan traps range from upper Cretaceous to Lower Eocene though they are confined to Meso Cenozoic transition period. In some cases, these have attained a thickness over 2000 metres. The evolution of the Deccan synclise was completed with this event. (ONGC 68).

#### 6. REMOTE SENSING APPROACH FOR THE STUDY AREA

Map 2 represents the various lineaments identified & interpreted using visual & digital image analysis. Digital image analysis was carried out on IMAVISION using EASI PACE Software. Various methods of enhancements like contrast stretch enhancement filtering, thresholding are applied to identify linear and curvilinear analysis. It was observed that these lineaments are occurring mostly NW & SW of India. Traces of lineaments are seen east of India.

##### 6.1 Lineament Trend Analysis

On the basis of interpreted map on lineament orientation map has been prepared. Maps shows that the trend is NE-SW. Trends are in between 10° - 24° and then 50°. The lineaments statistics in terms of Kms. is as under :

Zone No.	Lineament	Area in Kms.
1	6	460
2	6	182
3	98	300
4	4	23
5	2	17

##### 6.2 Tectonic Interpretation in Relation to Seismology

Map 3 represents the lineament orientation of the area. With the interpreted maps available to us, it is observed that the trend of the lineaments is parallel to major fold axis and represents the surface expression of some of these folds, fracture systems associated with the folding activity which are found to be faults & bedding trends. The lineament data indicates that this tectonic trend is NE SW compression. The topographical expression of these lineaments is reduced by the various exogenic processes.

#### 7. DISCUSSION & CONCLUSION

On the basis of observations made by the author in this field and subsequent maps prepared by the visual & digital analysis of the Landsat and IRS data and also on the basis of the tectonic evolution of the study area in light of the tectonic evaluation in relation to seismology of India, the following conclusions can be drawn :

1. The occurrence of tremors during and after the monsoon may be due to slicken side

effects of lack cotton soil as it behaves flexurally. Another aspect which needs emphasis is also the origin of black cotton soil. Basalts of the parent rocks are also found in weathered conditions. The amygdule fillings are mostly of flaky type of minerals like calcite, quartz, chalcedony. In some vesicules, reddish or greenish soft material fillings are also visible which serves as an opening for seepage and it may assist in slicken sliding phenomenon. The author is also of this opinion that even the presence of vertical, angular, horizontal and columnar joints can attribute to this type of phenomenon.

2. One important aspect for this can be the tectonic aspect which the author feels needs detailed investigation in the present context. Geomorphologically, the Narmada basin forms a large natural entity, consisting of hills, units, occurrence of lineaments fold axis and ring structures. Indier at Bhopal is seen to be associated with the concentric rings. The occurrence of this rings is primarily due to expansion within the structure apparantly formed as slight cover of older rocks overlies the resting magma. In all, seven concentric rings are oserved. Moreover, the presence

of fold axis which runs parallel to Narmada and along this numerous faults & basic intensives are seen which signifies that the area is structurally disturbed. (SONI 1990).

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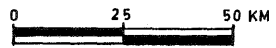
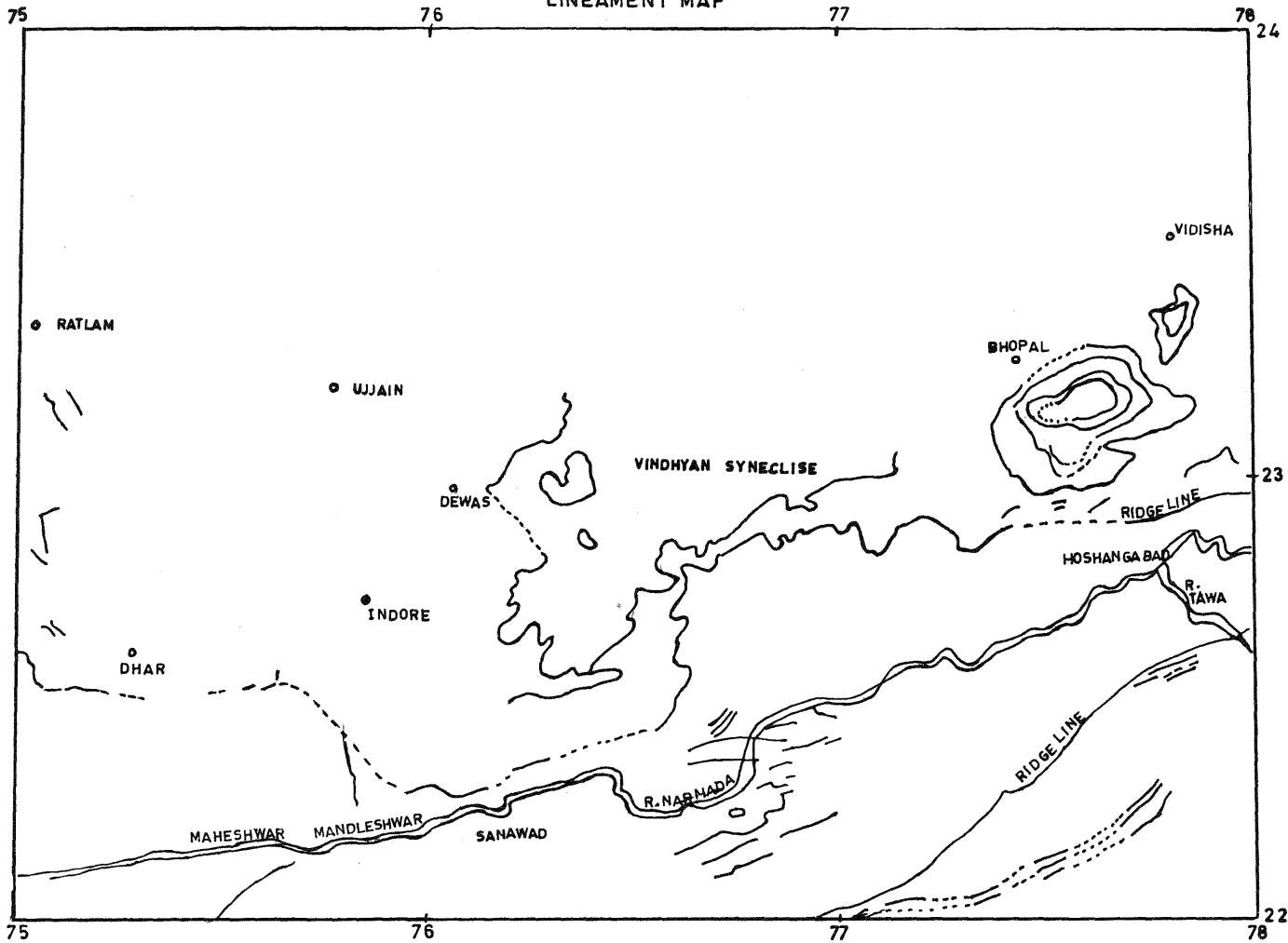
#### REFERENCES

1. A Guide to the Tectonic Map of India, published by Oil & Natural Gas Commission of India (1968).
2. SONI, S.K. (1990). Spatial Decision Analysis in Lineament Mapping Using IRS LISS II and Landsat TM Imagery for Central Narmada basin. 23rd International Symposium on Remote Sensing of Environment, Bangkok, Thailand.

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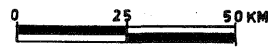
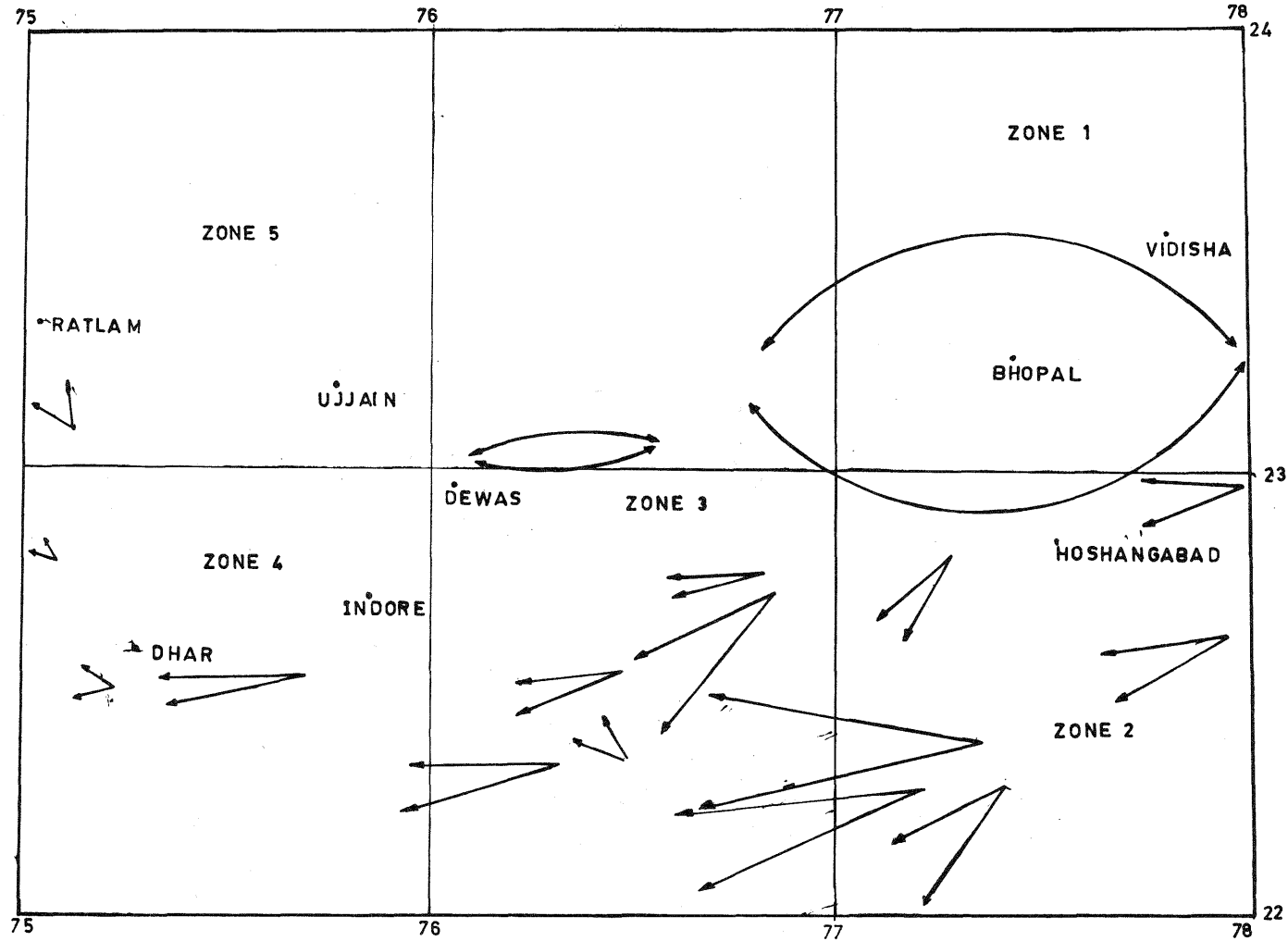


MAP NO.2  
LINEAMENT MAP



SOURCE LANDSAT TM & IRS LISS II DATA

LINEAMENT ORIENTATION MAP



LINEAMENT ORIENTATION

NOTE: ORIENTATION NOT ACCORDING TO SCALE