



## THE GEOLOGY OF THE DECCAN TRAP, MAHARASHTRA., INDIA

Pravin. S. Ingle

G. S. Tompe Arts, Commerce &amp; Science College, Chandur bazar, Amravati, Maharashtra

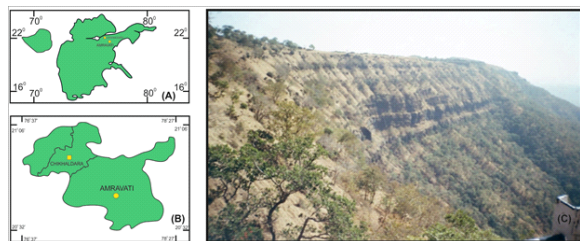
**ABSTRACT**

The Deccan Trap consisting of multiple layers of solidified flood basalt that contributes 2000m thick succession covering an area of about 518,000 sq. km<sup>2</sup> having volume of approximately 5,12,000 sq. km<sup>3</sup>. These rocks were formed about 60-68 my ago having an spread of about 1, 50,000 sq. km<sup>2</sup> area which is reduced to its current size by erosion and tectonic activities of continental plate restricted to Western and Central India. Recent evidence shows that the trap erupted over 8,00,000 years spanning the K-T boundary and therefore, may be a contributing factor for the extinction of many flora and fauna including dinosaurs. The Chikhaldara area, consisting a part of district Amravati, is marked by basaltic terrain of Deccan Trap. In the present study, an attempt has been made to interpret various geomorphic processes working in the area shaping present topography. An attempt has also been made on groundwater condition of the area. This study has been performed with the help of modern techniques like remote sensing.

**KEYWORDS :** Geomorphology, groundwater and remote sensing**Introduction**

The term "Trap" has been used in geology since 1789-95 which is derived from the Swedish word for stairs (trap, trappa) and refers to the step-like hills, forming the landscape as of the study area. The region of Deccan trap is also widely used as plateau which is an area of highland, usually consisting of relatively flat terrain. Thomson (1836) published the earliest geological sketch map of the Bombay Island which was further upgraded by Buist (1851). Blanford (1867) has given a detailed account of the geology of Deccan Trap including Inter-trappean beds of Western and Central India. Bose (1893) pointed out that dykes were probably the foci from which eruption of most lava took place. Recently, Sarma (2014) provided the geochemical signature of flow rocks of this area i.e., the basalts of this region are Fe-rich tholeiites (13.4 – 13.8 wt %) and characterization by high TiO<sub>2</sub> (3.64 – 3.94 wt %); moderate MgO contents (4.79 – 5.41 wt %); low K<sub>2</sub>O contents (<0.58 wt %) and low Mg (42.4 - 45.9). The palaeomagnetic study of the metadolerite dykes shows a direction of magnetisation Dm=29, Im=38 (α<sub>95</sub>=28.84; K=48.33; N=2) with palaeatitude of 21.3 N to the Indian subcontinent that clearly support the Proterozoic dyke/ dyke swarm emplacement in the region.

In the present study, an emphasis has been given on various geomorphic processes going on in the study area which are well reflected by drainage pattern, landuse, landcover pattern, structural units, topography and other related evidences, which are interpreted with the help of modern techniques, i.e., remote sensing and GIS.



**Fig. 1** Map showing the geographical spread of Deccan Trap a) in central and western India b) of Chikhaldara and c) panoramic view of the study area showing extensive exposure of basalt with various flows

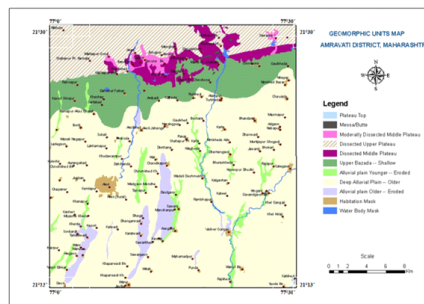
**Study area**

The study area of Chikhaldara located between 21° 15' to 21° 30' N lat. and 77° 15' to 77° 25' E long. lies at about 95 km NW of Amravati (Fig.1). It can be broadly divided into two i.e., i) low lying plain towards the banks of the Chandrabhaga River in the southeast and ii) abrupt cliffs consisting of horizontal Deccan Trap flows with multiple scarps towards the northern parts. The area shows high variation in topographic reliefs and falls in sub humid belt showing moderate winter with water being deficient. It is a good tourist place because of natural beauty. It is approachable from Amravati through road transport only. Figure 1(c) shows a panoramic view of the study area which itself provides a clear picture of different landforms that have been formed by natural agencies like erosional and denudational

processes. The lithological map shows that most of the area is covered with massive basalt and minor representation of alluvium (Fig. 2). The stepped appearance of landscape showing parallel retreat during pediplantation might have formed due to differential erosion of landforms. Numerous cross sections across the hilly terrain have demonstrated the presence of marked flat terraces at different levels indicating the penultimate cycle of erosion and landform development. The homogenous nature of the horizontally disposed lava flows with no conspicuous structural control towards the northern extremity of the area shows insequent drainage pattern. In general, the study area falls in moderate morphogenetic region with six different stages of landform evolution. The ridges show a trend of NE-SW direction, which are covered by thick soil indicating the intense weathering processes that might have affected the region. The maximum elevation is observed at Vairat (1177m) which lies towards SW of Chikhaldara whereas, the lowest minimum in Popatkhad area on Kasod – Shivpur route (355m). The data generate about the on morphogenesis, and other geomorphological factors with other elements of land, like geology, soil, hydrology and vegetation are presently used for various interpretation.

**GEOMORPHIC PROCESS**

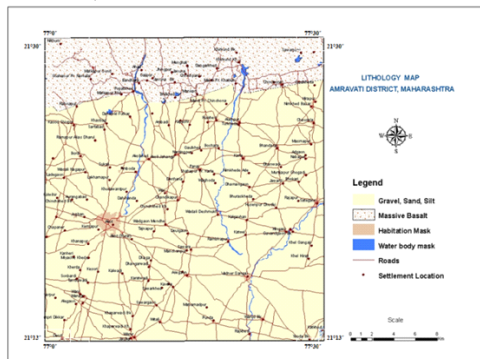
The area is dominated by the occurrence of horizontal lava flows of large aerial extent. The dominant geomorphic processes include spheroidal weathering and fluvial erosion, which aids to distinguish various geomorphic landforms. Earlier studies have indicated thermal origin for the same but, the recent studies based on field and petrological investigations reveal dominant role of chemical action for the same. Entire basaltic region is characterized by a flat crest and interim slope with a fairly constant angle off from the plain. Amphitheatrical valley head with narrow entrances and fairly steep sidewalls are common along the edges of the plateau and ridges (Fig. 2). Geomorphologically, the entire area is classified into plateau top, mesa/butte, moderately dissected middle plateau; dissected upper plateau, dissected middle plateau, upper bazada-shallow; alluvial plain younger-eroded; deep alluvial plain older-eroded; alluvial plain older-eroded; structural ridges and denudational hillocks (Fig. 3).



**Fig. 3** Various geomorphic units of the study area.

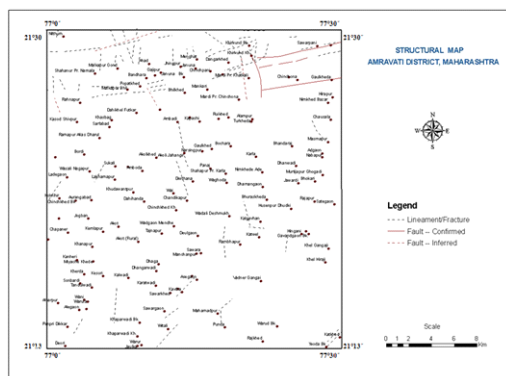
Structural hills consist of rocky landforms, which are either exposing the structures or showing structural trends (Fig. 4). They are prominent

because they form escarpments and mostly follow the trend of Satpura major fault. The groundwater in structural hills is absolutely rare, whereas, the rainwater mostly goes as surface runoff. Bazada zone represented by isolated upland, suddenly ejects out from the plains which are represented by the outcrops of bare and eroded nature. The loose material at the base of such hills form good recharge zone because of high porosity and permeability. Alluvial plain and surrounding zones are relatively better from groundwater point of view, except at a few places where these are of very shallow in nature. In general, they contain applicable amount of unconsolidated deposits and are put into extensive cultivation because of high moisture bearing capacity. Regarding groundwater potential zones, the sites containing intensive fracture/joints, moderately weathered pediplain, valley fills are the most preferred zones. Lineaments provide the pathways for groundwater movement and are hydrogeologically very important (Sankar et al. 1996).



**Fig. 2 Lithological map of the study area showing extensive cover of massive basalt. Remote sensing data interpretation**

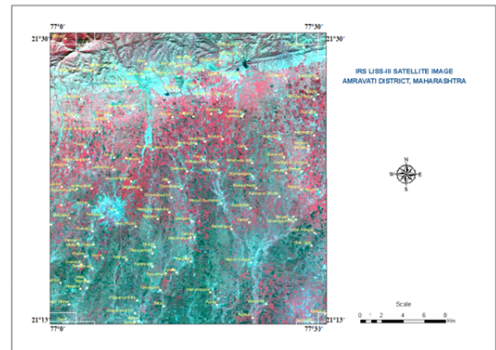
The detailed analysis of remotely sensed data through the digital interpretation indicates the predominance of basaltic terrain in the study area which can be grouped into five distinctly different geomorphic units namely, highly dissected plateau, moderately dissected plateau, denudation hill, alluvial plain and piedmont zone (Fig. 5). The light toned areas towards the south indicate low lying flood plain scattered in various drainage channels indicating changes in the stream courses in the geological past. The dark toned area suggests the occurrence of steep scarps. In general, the study area is dominated by the irregular topography due to variations in landscape which might have undergone considerable erosion as evidenced by the presence of elevated plateau surface, elongated linear ridges, mesa, butte and escarpments. For instance, the Gawilgarh Fault indicates an older age, whereas, the remaining lineaments represent a younger age.



**Fig. 4 Structural patterns of the study area.**

Remote sensing data interpretation also indicate the presence of linear ridges suggesting the dominance of lineaments, which can be recognized by the presence of positive linear ridges (Fig. 4). A close observation of IRS imagery suggests two generations of lineaments. Negative linear landforms showing low relief features may indicate the possibility of a fault particularly when they are sufficiently large. A smaller lineament indicates the presence of either fracture, shear or at place, basic dyke which follows a similar trend. The dark toned areas suggest the presence of vegetation over thick cover of in situ soil with fresh outcrops of lava flows mostly influenced by NNW - SSE fractures. Geomorphic units on the southern side consist of plains drained by the Pathar Nala, which for the most part takes a meandering

course indicating its maturity. There are some minor evidences of relict drainage pattern suggesting the possibility of recent or neotectonic activities in the area. Alluvial flood plain deposits are scattered over the area in and around various palaeo-channels of drainage network indicating the possibilities of certain changes in the stream courses during different periods of geological past. It is suggested that temporal satellite data along with aerial photo - interpretation would probably throw more light on various changes in the river channel courses and also neo-tectonic activity (Fig. 5).



**Fig. 5 IRS LISS-III satellite image of the study area.**

On the basis of various image characteristics, various geomorphic and morpho-tectonic units can be broadly grouped into, structural, fluvial and denudational landforms indicating trifacial origin. A brief idea about various geomorphic units are as follows;

1. Structural Origin:- These are formed because of the entire basaltic terrain can be broadly grouped as Deccan Trap plateau however, on the basis of dissection it can be further sub divided into two units as follows;
  - i) Highly dissected basaltic plateau: The landforms of this type occur in the northwest and central part of the study area which is demarcated by the presence of high hills with several dissections. This landform is characterized by steep outcrops with thin soil cover.
  - ii) Moderately dissected basaltic plateau: This landform is generally surrounded by the highly dissected basaltic plateau. Moderately high hills with medium dissections are the characteristics feature of this landform, that also serves as groundwater recharge zone.
2. Fluvial Origin: These landforms are formed it can be grouped into two categories;
  - i) Older Alluvium: This alluvial plain represents ancient flat surface of large aerial extent and gentle sloping towards South. It indicates earlier cycle of deposition and the basement rock beneath this plain is Deccan Basalts with uneven basement topography. The alluvial material consists of clay, sand and gravel. It occurs between the Pathar Nala and Satpura hill range.
  - ii) Younger Alluvium: This unit mainly differs from the older flood plains in the cycle of deposition and occurs at relatively lower level. It is characterized by the scraps of badlands topography resulting from severe soil erosion.
3. Denudational Hill: These are formed this landform represents low lying isolated hillocks and are seen scattered in different region of the study area.

#### Groundwater Conditions

Groundwater condition in the study area is poor because of hard basaltic terrain, unusable aquifer condition having limited water retention capacity and low rainfall. The recharge of groundwater is controlled by topography, thickness of weathered zone, vegetation and infiltration capacity of soil and sub soil strata within the zone of aeration. The water bearing capacity of various lava flows depends on the flow nature and geomorphic expression. The massive portions show low porosity due to the lack of openings and hence, unproductive for groundwater; whereas, the vesicular and amygdaloidal horizons of lava show interconnected and uniformly distributed vesicles contributing to their groundwater potential due to high degree of porosity and permeability which further increases with weathering. Occasionally, the closely spaced inter-connecting joints, if present in between the massive horizons may contribute towards formational porosity and forms productive zones. The size and number of vesicles, degree of weathering and joint pattern control the water productivity and yielding capacity of aquifers in the study area. Hence, highly weathered zones of vesicular and amygdaloidal basalts are potential

zones of groundwater. The red/green bole horizons in the area are less productive due to their clayey nature which tends to stop the vertical movement of groundwater because they act as confining aquicludes.

## CONCLUSION

- 1) The lava flows exposed are distinguished with one another due to their stratigraphic position, textural parameters like aphyric, microphyric and porphyritic nature. Aerial photographs, IRS LISS III satellite image and SOI Toposheets have been studied and interpreted for drainage pattern, regional geology, demarcation of different flow units, structural trends, geomorphology and hydrogeological condition.
- 2) Overall analysis shows the presence of plateau top, mesa, butte, moderately dissected middle plateau, dissected upper plateau, dissected middle plateau; upper bazada-shallow; alluvial plain younger-eroded; deep alluvial plain-older; alluvial plain-order-eroded; habitation mask and water body mask.
- 3) The identified landuse/landcover features are agriculture, plantation, deciduous forest, degraded forest scrubland, gullied land, forest plantation, shifting cultivation, lakes/reservoirs and road network.
- 4) Lineaments provides the pathways for groundwater potential zones, the sites containing intensive fracture/joints, moderately weathered pediplain, valley fills are the most preferred zones.
- 5) Regarding groundwater potential zones, the occurrences of multiple aquifer system have been noticed that shows both productive and unproductive zones due to the presence of alternating massive and vesicular units with lateral variations. The weathered and jointed zones in the massive units as well as vesicular and amygdaloidal units forming good aquifers of basalts are demarcated in this region. The depth of water table indicates three distinct horizons, which include shallow water level (1.5 - 5 m), moderately deep water level (5 -8 m) and very deep water level (>15 m).

## REFERENCES

1. BUIST, G., 1851. The geology of Bombay. Bombay Geol. Trans. Vol. 10, pp. 167-214.
2. BLANFORD, W.T. 1867 On the geology of a portion of Cutch. Mem. Geol. Soc. Ind. Vol. 6, pp. 17-38.
3. BOSE, P. N., 1884 Geology of the lower Narmada Valley between Nimawar and Kawant. Mem. Geol. Soc. Ind., vol. 21(1) Rocks Princeton University Press, Princeton, New Jersey, pp. 332.
4. SARMA, K. P., VENKATESHWARLU, M., PATIL, S. K., LASKAR, J. J. AND NIVA RANI DEVI., 2014 Palaeomagnetism of metadolerite dykes and sills from Proterozoic Shilong Basin, NE India: Implications related to the age and magnetism. Jour. Geol. Soc. India. Vol. 83, Feb. 2014, pp. 147-155.
5. SANKAR, K., JEGATHEISAN, M.S AND BALASUBRAMANIAN, A., (1996) Geoelectrical Resistivity a. studies in the Kanyakumari District, Tamil Nadu. Jour. Applied Hydrology. IX, 1 and 2, 83-90.