Impact Factor (SJIF): 6.126 E-ISSN: 2583-1615, P-ISSN: 3049-3498

International Journal of Research in Academic World

Received: 22/June/2025 **IJRAW:** 2025; 4(8):10-13 **Accepted:** 01/August/2025

Rocks and Landforms of Asirgarh Area, M.P. India: A Field-Based Perspective

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Abstract

The geology and geomorphology of the study area, situated between latitudes 21°11′–21°52′N and longitudes 75°55′–76°30′E within Burhanpur District, Madhya Pradesh, reflect a complex interplay of volcanic construction, chemical weathering, and fluvial processes. The region forms part of the central highlands of the Deccan Plateau and is characterized by approximately 460 m of horizontally bedded basaltic lava flows belonging to the Deccan Traps (Malwa Group), emplaced during Late Cretaceous–Early Paleogene volcanism. These basalt flows define extensive plateaus and ridges, while Quaternary alluvium, restricted to the Tapi and Chhota Tawa river valleys, forms narrow floodplains and depositional tracts.

Field mapping and stratigraphic logging reveal the presence of both "aa" and "pahoehoe" basaltic flow types, distinguished by columnar jointing, vesicular zones, and mineral-filled amygdales. Petrological observations indicate significant chemical alteration, with secondary minerals such as chlorite, calcite, and zeolites filling vesicles, underscoring the role of post-volcanic weathering in modifying the basaltic terrain. Geomorphologically, the landscape exhibits feature of a mature fluvial system, with spheroidal weathering shaping upland plateaus and fluvial erosion sculpting valleys and transporting sediments to form alluvial plains.

The integrated analysis suggests that the present landscape represents a transitional phase wherein primary volcanic features are progressively reworked into secondary geomorphic forms under subtropical climatic conditions. This study highlights the importance of combining geological and geomorphological approaches to understand the long-term evolution of the Deccan Plateau.

Keywords: Landforms, Field, Geomorphology.

Introduction

The study area lies between 21°11′–21°52′ N latitude and 75°55′–76°30′ E longitude (Fig. 1) and corresponds to Survey of India toposheets 55C/1 to 55C/8. It encompasses an approximately 460 m-thick sequence of Deccan basaltic lava flows, covering an area of about 4,000 km² within Burhanpur District, Madhya Pradesh.

The region is primarily drained by the Tapi River and its tributary, the Chhota Tawa River. Geomorphologically, the area occupies the interfluve between the Narmada and Tapi valleys, situated on relatively flat terrain along the northern bank of the Tapi River and flanked by the Satpura Ranges.

The Tapi River is one of the three major peninsular rivers of India flowing east to west, the other two being the Mahi and Narmada rivers. It originates from the eastern segment of the Satpura Mountain Range in southern Madhya Pradesh, and its westward course plays a significant role in shaping the geomorphology of the basin.

Geological Framework: Regional Geological Setting

The study area forms part of the Deccan Volcanic Province (DVP), one of the world's most extensive continental flood basalt provinces, emplaced during the Late Cretaceous to Early Paleogene (Table 1). The flows in this region belong to the Malwa Group of the Deccan Traps and are overlain in places by Quaternary alluvium deposited along active river courses (Khadri, *et al*. 2018) [6] (Khadri, *et al*. 1996 a & b, Bodas, *et al*., 1988) [5, 4, 1]. The Deccan Traps here represent successive eruptions of basaltic lava, forming a sequence of 'aa' and 'pahoehoe' flows, which together define the lithological and geomorphic characteristics of the region. The lithological succession is dominated by basaltic lava flows with subordinate alluvial deposits along river valleys.

Table 1: Stratigraphic Table of Study Area.

Age	Formation/Group	Lithology	Distribution
Quaternary	Alluvium	Clay, silt, gravel, occasional cobbles	Along river courses
Cretaceous–Lower Eocene	Deccan Traps (Malwa Group)	Massive to vesicular basaltic flows ('aa' and 'pahoehoe')	> 2/3 of area

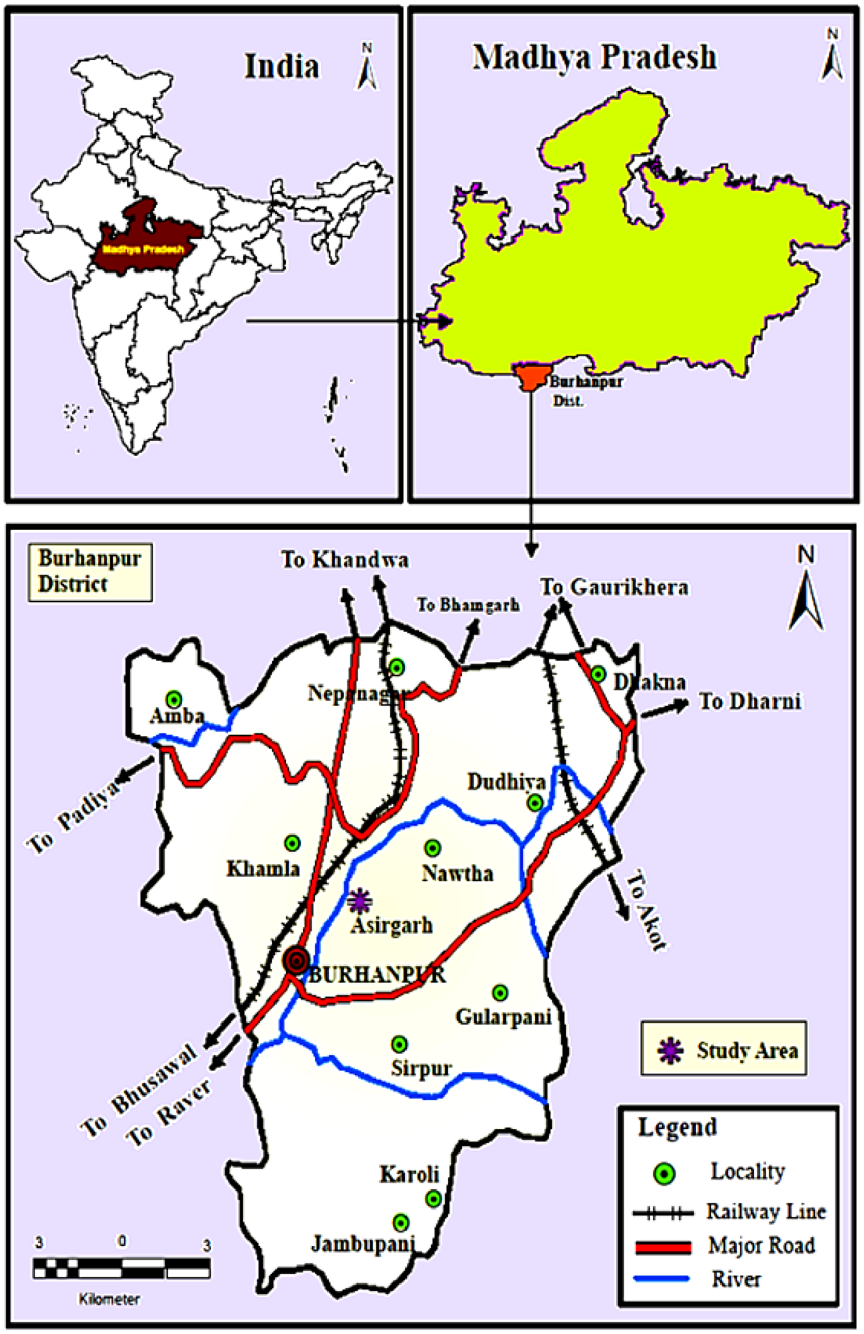

Fig 1: Location map of Study Area

Field Characteristics of Basaltic Flows:

The 'aa' flows are distinguished by their thick, massive lower sections, which exhibit columnar jointing and spheroidal weathering. The upper sections are vesicular, with frequent brecciation indicative of fragmentation during cooling.

The 'pahoehoe' flows are characterized by thin, vesicular basalt with localized massive zones. The vesicles are typically highly asymmetrical. The basal portions of these flows exhibit ropy structures and contain amygdales, which are filled with chlorite, calcite, zeolites, and devitrified volcanic glass.

Field Observations and Methods:

Field investigations formed the foundation of this study and were carried out systematically to document the geological and geomorphological characteristics of the area. Geological mapping was undertaken at a scale of 1:50,000 using Survey of India toposheets (55C/1 to 55C/8). This allowed the delineation of different lithological units, particularly the distribution of basaltic lava flows and Quaternary alluvium, as well as the identification of major geomorphic features. During mapping, careful attention was given to distinguishing between massive and vesicular flows, recording their lateral and vertical variations, and noting structural features such as joints and fractures that influence landscape development.

Stratigraphic logging was conducted at representative locations to measure the thickness and internal characteristics of the basaltic flows. Detailed observations were made to classify the flows into 'aa' and 'pahoehoe' types based on their textures and structures. Features such as columnar jointing, spheroidal weathering, vesicular zones, brecciation, and the occurrence of amygdales were systematically recorded. These logs provided the basis for constructing a generalized stratigraphic framework of the study area.

In addition, geomorphological observations were carried out to document the surface features and landform assemblages. Plateaus, structural ridges, and floodplains were identified and their spatial relationships to lithology and structure were noted. Drainage characteristics, including pattern, density, and anomalies, were examined to infer the influence of underlying geology and tectonic controls on landscape evolution.

Synthesis and Interpretation

Geomorphology is defined as the study of landforms, their processes, form and sediments at the surface of the Earth (and sometimes on other planets). In geomorphological study include looking at landscapes to work out how the earth surface processes, such as air, Water and ice, can mould the landscape. Landforms are formed by erosion or deposition, transported and deposited to different localities. The dissimilar climatic environments create dissimilar suites of landforms. The landforms of deserts, such as sand dunes and ergs, are a world apart from the glacial and periglacial features found in polar and sub-polar regions. Geomorphological map the distribution of different landforms so as to recognize enhanced their occurrence.

Earth-surface processes are forming landforms recent, changing the landscape, albeit often very slowly. Most geomorphological processes activate at a slow rate, however occasionally a large event, such as a landslide or flood, occurs causing rapid change to the environment, and sometimes threatening humans. So geological hazards, are such as volcanic eruptions, earthquakes, tsunamis and landslides, fall within the interests of geomorphologists. Advancements in remote sensing from satellites and GIS mapping has benefited geomorphologists greatly over the past few decades, allowing them to understand global distributions.

Geomorphologists are also known as landscape-detectives and they are working out the past of a landscape. Most of the environments, like Britain and Ireland have in the past been glaciated environments, thousands of years ago. These glaciated environments have left their mark on the landscape, like the steep-sided valleys in the Lake District and the drumlin fields of central Ireland. Geomorphologists can part jointly the past of such places by investigation the geomorphology and sedimentology – frequently the particles and the organic material, such as pollen, beetles, diatoms and macrofossils preserved in lake sediments and peat, can provide evidence on past climate change and processes.

The study area represents a segment of the Deccan Plateau, forming part of the central highlands of the Indian Peninsular Plateau. Field observations reveal that the region is dominated by horizontal basaltic lava flows of the Deccan Traps, which were emplaced during extensive volcanic activity in the Late Cretaceous–Early Paleogene period (fig 3). These flows exhibit a large aerial extent, creating broad plateaus and structural uplands that define the physiographic character of the region. Interspersed within this volcanic terrain are Quaternary alluvial deposits, which occur as relatively narrow but prominent tracts along the Tapi River, the Chhota Tawa River, and their tributaries. These rivers, displaying features of a mature fluvial stage, have carved wide valleys, formed well-developed floodplains, and contributed significantly to sediment deposition, giving rise to extensive alluvial plains.

The geomorphic framework of the area is controlled by a combination of lithology, structure, and active surface processes (Khadri, *et al.* 2013) [3]. Massive basalt flows undergo spheroidal weathering, producing rounded boulders and disintegrating rock masses along plateau margins and slopes. In contrast, fluvial erosion dominates in the river valleys, where streams incise through basalt layers, transport sediments, and facilitate the development of depositional features such as floodplains and terraces. These processes collectively divide the landscape into distinct geomorphic units: elevated volcanic plateaus, dissected ridges, and low-lying alluvial tracts.

Earlier studies have largely attributed the physiography of this region to its thermal (volcanic) origin, emphasizing the role of lava emplacement in shaping its primary structure. However, the present investigation, supported by field mapping and petrological analysis, highlights the critical influence of chemical weathering in modifying the basaltic terrain over geological time. Chemical alteration of basalt is evident from the presence of secondary minerals such as chlorite, zeolites, and calcite filling vesicles and amygdales, as well as from the development of weathering profiles across flow units. These observations suggest that post-volcanic processes have played an equally significant role in landscape evolution, progressively transforming primary volcanic landforms into secondary geomorphic features.

In synthesis, the geology and geomorphology of the study area reflect a dynamic interplay between volcanic construction, chemical weathering, and fluvial dynamics. The current landscape is transitional in nature, representing a phase where primary volcanic structures are being systematically reworked by surface processes under subtropical climatic conditions. This interpretation underscores the importance of integrating field geology with geomorphological analysis to understand both the origin and the ongoing evolution of the Deccan Plateau terrain.

Fig 2: A view of Hill Landform at Rajpura of study area.

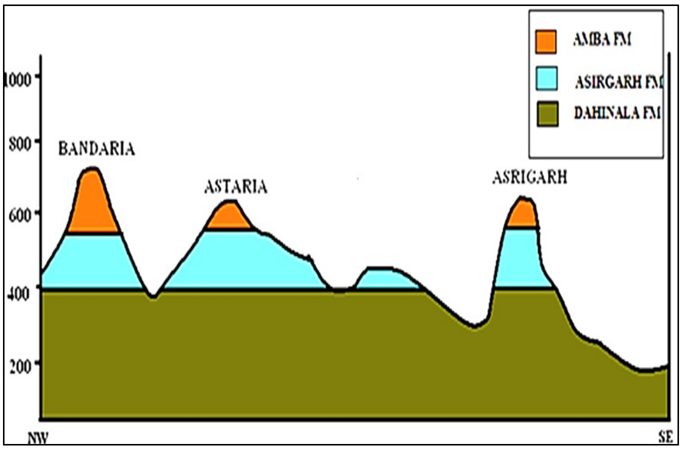

Fig 3: NW-SE cross section through the lava pile on the basis of geological map

Conclusions

The geology and geomorphology of the study area illustrate a landscape shaped by the interaction of volcanic construction, weathering, and fluvial processes over geological time. The area, forming part of the central highlands of the Deccan Plateau, is predominantly underlain by thick, horizontally bedded basaltic lava flows of the Deccan Traps, which were emplaced during extensive volcanic activity in the Late Cretaceous–Early Paleogene period. These flows define the elevated plateaus and structural ridges that dominate the region, while Quaternary alluvium, deposited by the Tapi and Chhota Tawa rivers and their tributaries, forms narrow floodplains and alluvial tracts that represent the most recent phase of surface modification.

Geomorphic observations indicate that spheroidal weathering of massive basalts has progressively altered primary volcanic landforms, producing rounded boulder landscapes and weathered profiles. At the same time, fluvial erosion and deposition by the river systems have carved broad valleys, transported sediments, and created extensive alluvial plains, contributing to the differentiation of distinct geomorphic units—volcanic uplands, dissected ridges, and depositional lowlands.

Earlier interpretations emphasized a dominantly thermal (volcanic) origin for this terrain, attributing its physiography solely to lava emplacement. However, evidence from field mapping and petrological studies in the present investigation highlights the significant role of chemical weathering, as indicated by mineral alterations and secondary infillings (chlorite, zeolites, calcite) within vesicles and amygdales. This suggests that post-volcanic processes have been equally critical in shaping the current landscape.

In conclusion, the study area represents a transitional landscape, where primary volcanic structures are being systematically reworked into secondary geomorphic features under subtropical climatic conditions. The combined influence of volcanic, chemical, and fluvial processes underscores the need for an integrated approach to understanding the region's geological and geomorphological evolution.

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