

"From Magmatic Reservoirs to Solid Rocks: A Deep Dive into the Origin and Evolution of Deccan Trap"

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Abstract:

The term "Deccan Trap," introduced by W.H. Sykes in 1833, characterizes the step-like or terrace-like topography found in the Deccan Trap terrain, the second most extensive geological formation in peninsular India. The Deccan Traps, a vast and intriguing geological formation, have captivated the attention of researchers and geologists for decades. Spanning across the Marathwada region, this extensive lava plateau holds a profound story within its solidified rocks, one that unfolds through the intricate processes of magma origin and evolution.

This research paper delves into the intricacies of the Deccan Trap, specifically in the Marathwada region. The total thickness of the Deccan Trap varies across different areas due to the undulating nature of the underlying terrain. The west coast, near Bombay, exhibits a thickness of over 2000m, while other regions, such as Matheran, Sahyadri, and Melghat scarp, display varying thicknesses. Understanding the nature of volcanic activity that produced these lava flows is crucial for deciphering the geological history of the Deccan Trap.

The study employs a detailed analysis of lava flows, considering their field characters as indicators of volcanic activity. The classification of flows into compact basalt and amygdaloidal basalt reveals distinct characteristics. Compact basalt flows, thick and extensive with a high ratio, are devoid of gas cavities. In contrast, amygdaloidal flows, limited in lateral extent with a low ratio, display vesicular characteristics throughout their thickness, indicating the influence of gas cavities.

This research contributes valuable insights into the volcanic history of the Deccan Trap, shedding light on the fluidity and viscosity of the lava that shaped its unique topography. The findings provide a foundation for understanding the geological processes that led to the formation of one of India's most remarkable geological features.

Key words: Deccan Trap, Geological Formation, Magma Origin, Lava Flows, Volcanic Activity

Introduction:

The Deccan Trap, an expansive geological canvas etched over epochs, beckons exploration into the intricate journey from magmatic reservoirs to solid rocks. Spanning the Upper Cretaceous to Lower Eocene ages, the Deccan Traps lava flows cloak the region, leaving an indelible mark on the landscape. Nestled beneath a delicate veneer of thin alluvial deposits along river courses, these basaltic lava flows stand as the singular major geological formation in the area, creating an opportune window to scrutinize their origin and evolution.

This geological tapestry reveals a story of temporal transitions, where molten magma once surged from magmatic reservoirs, cooling and solidifying into the enduring rocks that shape the Deccan Trap. A crucial feature is the horizontal sprawl of the lava flows, each a testament to the geological drama that unfolded in the Upper Cretaceous to Lower Eocene period.

Delving into the stratigraphic layers of the Deccan Trap, each lava flow unveils a dual identity. The upper layers, a spectacle of vesicular and amygdaloidal zeolitic basalt, bear witness to a dynamic phase of volcanic activity characterized by the entrapment of gases. In contrast, the lower layers reveal a stoic foundation of massive basalt, a testament to the cessation of volcanic fervor and the onset of solidification.

The juxtaposition of these distinct units within each lava flow prompts an in-depth investigation into the conditions that governed their formation. The thin alluvial deposits along riverbanks, delicately resting atop the lava flows, further add layers to the geological narrative, offering insights into the region's dynamic environmental history.

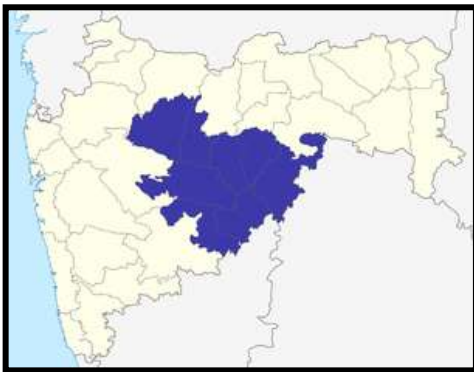
This research endeavors to unravel the complexities enshrouding the Deccan Trap's magmatic genesis and the ensuing evolutionary journey toward solid rocks. Through meticulous field studies and analytical scrutiny, we aim to contribute to a deeper understanding of the geological processes that sculpted this unique landscape, providing a window into the transformative interplay between magmatic reservoirs and the enduring rocks of the Deccan Trap.

Study area:

The central coordinates, marking the heart of Marathwada, serve as the anchor for this study. Latitude 19.7515° N and Longitude 75.7139° E place the research focus within the broader context of this region, ensuring a comprehensive examination of its geological characteristics.

Sahyadri Mountain Range:

To the west of Marathwada lies the imposing Sahyadri mountain range, known for its rugged terrain, diverse flora and fauna, and intricate geological formations. This study aims to unravel the geological intricacies embedded in the Sahyadri range, providing insights into its formation and evolution over time.



Ajanta Mountain Range:

To the north of Marathwada, the Ajanta mountain range adds another dimension to the region's geological narrative. Famous for the ancient Ajanta Caves, this mountain range is a testament to the geological processes that have shaped the landscape. The research endeavors to explore the rock formations, structural features, and tectonic influences within the Ajanta range.

Research Methodology:

This research aims to meticulously unravel the complexities surrounding the magmatic genesis and evolutionary journey of the Deccan Trap towards solid rocks. Employing a comprehensive methodology, the study is designed to contribute valuable insights into the geological processes that have sculpted this distinctive landscape, shedding light on the transformative interplay between magmatic reservoirs and the enduring rocks of the Deccan Trap.

Selection of Study Sites:

Ghate Section: The Ghate Section, chosen strategically for its geological significance, will serve as a primary study site. The exposed basalt flows in this section offer a rich repository of information regarding the composition, structure, and field characteristics of the rocks within the Deccan Trap.

Well Section Exposures: addition to the Ghate Section, well sections with exposed rock formations will be selected to ensure a comprehensive data collection. These exposures are vital in capturing variations in lithology and mineralogy at different depths, providing a more nuanced understanding of the geological processes.

Field Studies:

Bed Flows of Basalt Rock Examination: In the Ghate Section, an intensive field study will be conducted, focusing on the exposed bed flows of basalt rock. Detailed observations will include the identification of vesicular and amygdaloidal zeolitic basalt in the upper layers and massive basalt in the lower layers. Measurements of thickness, lateral extent, and structural features will be recorded.

Well Section Exposures: Field surveys at well sections will involve the examination of rock exposures, with an emphasis on documenting lithological variations, stratigraphic relationships, and any observable features indicative of magmatic processes and evolution.

Types of Flows Constitute The Deccan Trap Basalts.

The normal plagioclase-augite basalt is the predominant rock type, but olivine has been altered to iddingsite occurring as reddish brown shining flakes, but many flows contain olivine in fresh unaltered condition in abundance. Completely aphanitic basalts are common. But porphyritic varieties with phenocryst of plagioclase of different sizes are perhaps more abundant.

1. Compact Basalts (Aa Flow)

2. Amygdaloidal Basalt and Vesicular Basalt (Pahoehoe flow):
3. Tachylytic Basalt (Red bole)
4. Volcanic Breccia
5. Alluvial

1. Compact Basalts (Aa Flow):

Aa Flow a term of Hawaiian origin used in reference to basaltic lava that occurs in flows with a fissured tough and jagged surface.

Compact basalt flows are always thick and extensive having tabular forms. The thickness of flow varies from 2 meter to 60 meter. Its top surface is hydro-thermally altered purple to green colour which is vesicular or amygdaloidal and free from jointing. Due to jointing rock has dissected appearance. There may be variation in the pattern of jointing and joint spacing. Joints may be closely spaced or broadly spaced and sometimes may not be interconnected. Karmarkar B.M. (1974), Gupte R. B., et al (1974); Kulkarni S. R. (1975); Gupte R. B. et al (1977); Marathe S. S. et al (1980)]



Top surface of the compact basalt flow:

The top portion of compact basalt flow is always vesicular, amygdaloidal, unjointed and watertight in fresh condition. The vesicles are not interconnected and their vesicular nature is obliterated since in the top portion of flow, most of these vesicles are filled with zeolites and silica calcite. All these vesicles are independent from each other and no interconnected therefore they do not provide avenue for the transmission and circulation of the rain water.

Middle compact basalt flow:

The middle and lower portion of compact basalt flow is black in colour, nonvascular, aphanitic or porphyritic in nature. It is in the dissectioned condition due to development of joints which are contraction cracks formed during cooling and consolidation of the lava. Variation in the jointing pattern is observed in the middle and lower portion of the compact basalt flows.

Bottom portion of the compact basalt flows:

Immediately above the bottom surface of the compact basalt flow, a narrow strip of the vesicles and the amygdales occur, which is parallel to the bottom of the flow.

Lithologically two compact basalts flows may be similar but there is distinct difference in the jointing pattern. One flow may show broadly jointing, whereas the other may have closely paced or inconsistent jointing.

With appearance of weathered surfaces of joint blocks, to flows can be demarcated from each other. The compact aphanitic basalt always developed smooth surfaces whereas porphyritic variety of basalts developed rough and pitted (appearance) surfaces on weathering, because of dislodging of plagioclase phenocryst.

Giant-phenocryst basalts:

Normally the laths of plagioclase occurring as phenocrysts are only upto 1 cm in length, but in some porphyritic basalts the laths are very large, from 2 cm to 10 cm in length. Such basalts are called giant-phenocryst basalt, and are very common all over the area. They actually are predominant rock types in some districts of Maharashtra. In some of the giant phenocryst basalts there are granules of iddingsite indicating there phenocryst of olivine were also formed.

Hydrothermal alteration:

Further variety is produced by the different degrees of hydrothermal alteration produced in the basalts by magmatic gases. Fresh unaltered basalt have a dark blue or black colour. The colour is changed by hydrothermal alteration to shades of brown, pink, red, purple or green, and basalts showing these colours are widespread.

2. Amygdaloidal Basalt and Vesicular Basalt (Pahoehoe flow) :

On the basis of the thickness and lateral extent amygdaloidal basalt flows are mainly grouped into two categories viz. thin irregular amygdaloidal basalt flows having maximum thickness upto 6 meters and lateral extent upto few kilometers and thicker amygdaloidal basalt flows having thickness upto 100 meters and lateral extent upto few kilometers and average thickness between 10 to 20 meters.

Some geologist terms this flow as ‘Compound Pahoehoe Flow’ (Nicholas 1936). Both these flows are characterized by bulbous irregular form, rapidly pinching out, and presence of ropy top surface and pipe amygdales along the bottom of the flow. However, these are un-jointed when fresh and amygdaloidal throughout its thickness. Sometimes middle and bottom portions of these flows are free from vesicles and amygdales in which jointing is developed. Volcanic Breccia it is heterogeneous rock in which angular fragment of different. Types of basalt are held together either in red Tachylytic matrix or in zeolites matrix or in grey lava matrix. It has limited field occurrence in the terrain.



In the Deccan Traps vesicular basalts are rare as most of them have been converted into amygdaloidal basalts by the filling of vesicles by secondary mineral. True vesicular basalts with open gas cavities are rare and the amygdaloidal basalt are widespread. As the vesicular basalt is unjointed fresh and compact they are quite impervious.

i) Pipe amygdales

Pipe amygdales generally occur in a row along bottom of the Amygdaloidal basalt flows which help in demarcating the junction between the flows.

ii) Top surface of the flow

The top surface of Amygdaloidal basalt flow is generally Tachylytic and reddish brown in colour. Therefore in vertical cut the top surface of the flow is seen as reddish brown shining line. As Tachylytic is unstable under atmospheric conditions, a groove is formed the along the flow junction due to removal of Tachylytic material.

iii) Ropy surface

On top of the Amygdaloidal basaltic flow, ropy and wrinkled surfaces are observed. take figure from sir On the basis of thickness and the lateral extent, Amygdaloidal basalt flows are mainly grouped into two categories, some scholars have called these flows as compound, and Pahoehoe flows (Nichols, 1936). a) Thin irregular, amygdaloidal basalt flows and, b) Thick, irregular, amygdaloidal basalt flows. a) Thin irregular, amygdaloidal basalt flows: Their thickness varies from a few cm to 6 meter. They can be traced laterally up to distance of 40 meter. Such small irregular flows are Amygdaloidal through out there thickness. These are unjointed when they are fresh.

4. Tachylytic Basalts :

Tachylytic basalts are basaltic glass formed due to rapid cooling and chilling of the lava. It has very much closely spaced mutually perpendicular three sets of joints. Tachylytic basalts have different shades of colour, such as red, green, brown and black. However, red colour is very common.

They occur as thin band and pockets and lenses between the lava flows and also as irregular, thin intrusion in the top portion of the flow, when Tachylytic bands occur between the flows their thickness varies from a few centimeters to sometimes upto 3 m. The peculiarity of the Tachylytic basalts is that, in confined condition, below the cover of rock, it occurs as quite hard, red colour rock. But only on exposure to atmospheric conditions, it disintegrates and crumples into powder like material due to opening of joints. (A. V. Tejankar 2002)

7. Volcanic Breccia

Volcanic Breccias with Tachylytic matrix and grey lava matrix occur as water tight rock. Therefore no rain water percolates through them. In volcanic breccias in which rock fragments are held together by zeolites, some voids occur, therefore small quantity of water may percolates through them.

As mentioned previously, middle and lower portions of compact basalt flows are jointed. It jointed portions of Compact basalt flow are exposed at the surface; rain water percolates through joints forming ground water. However, quantity of percolation of water depends upon joint spacing and pattern of jointing.

Conclusion:

In conclusion, the investigation into the Deccan Trap Basalts has revealed a diverse array of rock types, each telling a unique story of magmatic genesis and subsequent evolution. The predominant rock type observed is the normal plagioclase-augite basalt, with olivine presenting itself in both altered and unaltered states. The richness of the geological composition is further accentuated by the presence of completely aphanitic basalts, porphyritic varieties with phenocrysts of plagioclase, compact basalts, amygdaloidal basalt, vesicular basalt, tachylytic basalt, volcanic breccia, and alluvial deposits.

1. Compact Basalts (Aa Flow):

The Aa Flow, characterized by its fissured tough and jagged surface, presents a thick and extensive tabular form. The top surface, hydrothermally altered and vesicular, transitions to a black, nonvesicular middle and lower portion. Distinct differences in jointing patterns demarcate lithologically similar compact basalts, offering insights into the geological history of each flow.

2. Amygdaloidal Basalt and Vesicular Basalt (Pahoehoe Flow):

The amygdaloidal basalt flows exhibit a bulbous irregular form, rapidly pinching out, and a ropy top surface. With variations in thickness and lateral extent, these flows provide a glimpse into the intricate magmatic processes. Pipe amygdales and the reddish-brown shining line along the top surface contribute to the identification and demarcation of these flows.

3. Tachylytic Basalts:

Tachylytic basalts, formed by rapid cooling and chilling of lava, present closely spaced mutually perpendicular three sets of joints. The distinct shades of color, such as red, green, brown, and black, add to the geological diversity. The Tachylytic basalts' propensity to disintegrate upon exposure to atmospheric conditions underscores the dynamic interplay between rock formation and weathering processes.

4. Volcanic Breccia:

Volcanic breccias, with Tachylytic and grey lava matrices, contribute to the geological heterogeneity. Their water-tight nature impedes rainwater percolation, highlighting the potential significance of these formations in groundwater dynamics.

This comprehensive exploration into the Deccan Trap Basalts, encompassing a variety of rock types and geological features, deepens our understanding of the magmatic processes and evolutionary pathways that shaped this unique landscape. The distinct characteristics observed in each rock type serve as valuable indicators, paving the way for further research into the complex geological history of the Deccan Trap.

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