Deccan Volcanism and Movement of Indian Plate

For Prelims: **Tropical Flora**, **Volcanism**, **Indian Plate**, **Mass Extinctions**, **ITCZ**, **Cretaceous-Paleogene (K-Pg) Mass Extinction**, **Tropical Rainforests**, **Equator**, **Volcanic Plateau**, **Mantle Plume**, **Volcanic Hotspots**, **Réunion Hotspot**, **Gondwanaland**, **Tethys Sea**, **Himalayan Mountain**, **Monsoon**.

For Mains: Movement of Indian Plate and its impacts on deccan plateau, Volcanism.

Source: PIB

Why in News?

A new study revealed that **tropical flora** showed significant **resilience** during the **Deccan Volcanism** on **Indian Plate** while causing **mass extinctions** **of fauna**.

- Mass extinctions are **catastrophic events** causing **rapid biodiversity loss**, often triggered by climate changes, asteroid impacts, or **massive volcanic eruptions.**

What are the Key Findings of the Study?

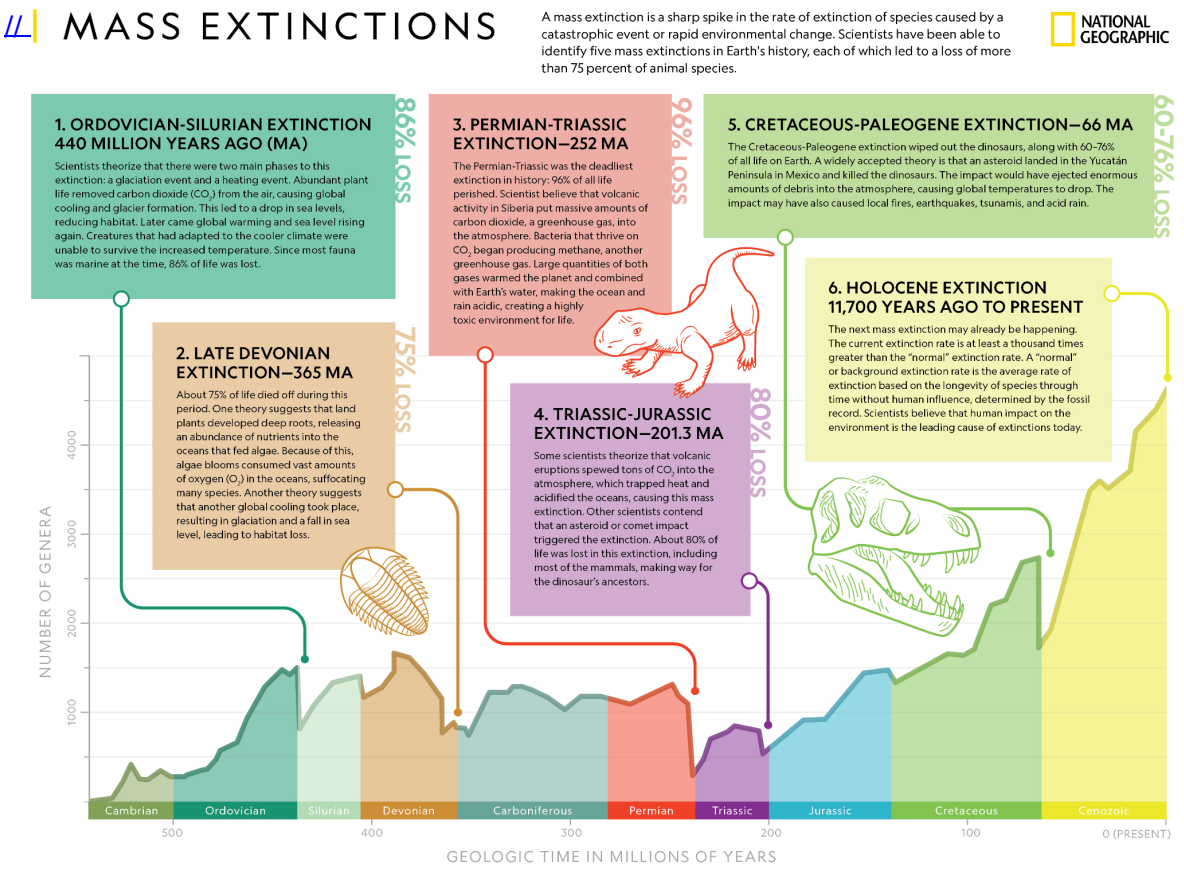
- **Impact on Fauna and Flora: Deccan Volcanism** caused **mass extinctions of dinosaurs** and other fauna, along with **gymnosperms.**
  - However, it **supported hyper-diverse tropical flora** by creating **fertile, undisturbed habitats** for angiosperms, rather than leading to floral extinction.
  - A **warm, humid climate** during volcanic inactivity and the **movement of the Indian Plate** through the **equator** helped floral diversity.
- **Global and Regional Implications**: Deccan volcanism was identified as a contributing factor to the **Cretaceous-Paleogene (K-Pg) mass extinction** **(66 million years ago)** that culminated in **ammonoid (invertebrate cephalopods)** and **dinosaurs** on the global scale.
  - However, **tropical rainforests** in the Indian Plate region **adapted and thrived,** indicating **higher resilience** of tropical flora to climatic stresses.

- **Tropical Flora: Tropical flora** refers to the plant species that thrive in **tropical regions (between 23.5° North and 23.5° South latitude)** of the world, which are typically characterized by **warm temperatures and high humidity** year-round.

  - These regions are found **near the equator,** between the **Tropic of Cancer and the Tropic of Capricorn.**
  - E.g., **Mahogany tree, Orchids, Coconut palms etc.**

- **Gymnosperms:** Gymnosperms produce **seeds that are not enclosed within an ovary (naked needs)** but are exposed, often on **cone-like structures.** They are among the **oldest and most primitive plants.**

- **Angiosperms**: They are a group of plants that produce **seeds enclosed within a fruit.** After fertilization, the **ovary** of the flower develops into a **fruit that contains seeds.**



What is Deccan Volcanism Theory?

- **About:** It suggests that the **volcanic eruptions** leading to the formation of **Deccan Traps** played a key role in the mass extinction event that occurred approximately **66 million years ago**.
    - The Deccan Traps are a **large volcanic plateau in peninsular India**, formed by **fissure volcanic eruptions.**
    - Fissure volcanic eruptions occur when **magma erupts through long cracks or fissures**, rather than through a central vent of a volcano.
- **Formation: Deccan Traps** are believed to have been formed by intense volcanic activity caused by the **Deccan mantle plume**. The volcanic activity continued for **several hundred thousand years.**
    - A mantle plume is a **cylindrical upwelling of hot magma** from the Earth's mantle, responsible for **volcanic hotspots** not linked to plate boundaries.
    - Presently, **Deccan Traps** consist of vast layers of **basaltic lava flows,** formed by large volcanic eruptions.
- **Connection with Indian Plate Movement**: India was a large island situated **off the Australian coast**. India is supposed to have started her **northward journey about 200 million years ago.**
    - Beneath the Indian Plate, **the Réunion hotspot is a mantle plume** of hot, molten rock from the Earth's interior. As the Indian Plate moved over the Réunion hotspot, **fissure volcanic eruptions** formed the **Deccan Traps.**
        - The **Réunion hotspot** is a volcanic hotspot located in the **Indian Ocean**, near the island of **Réunion** (a French overseas region).

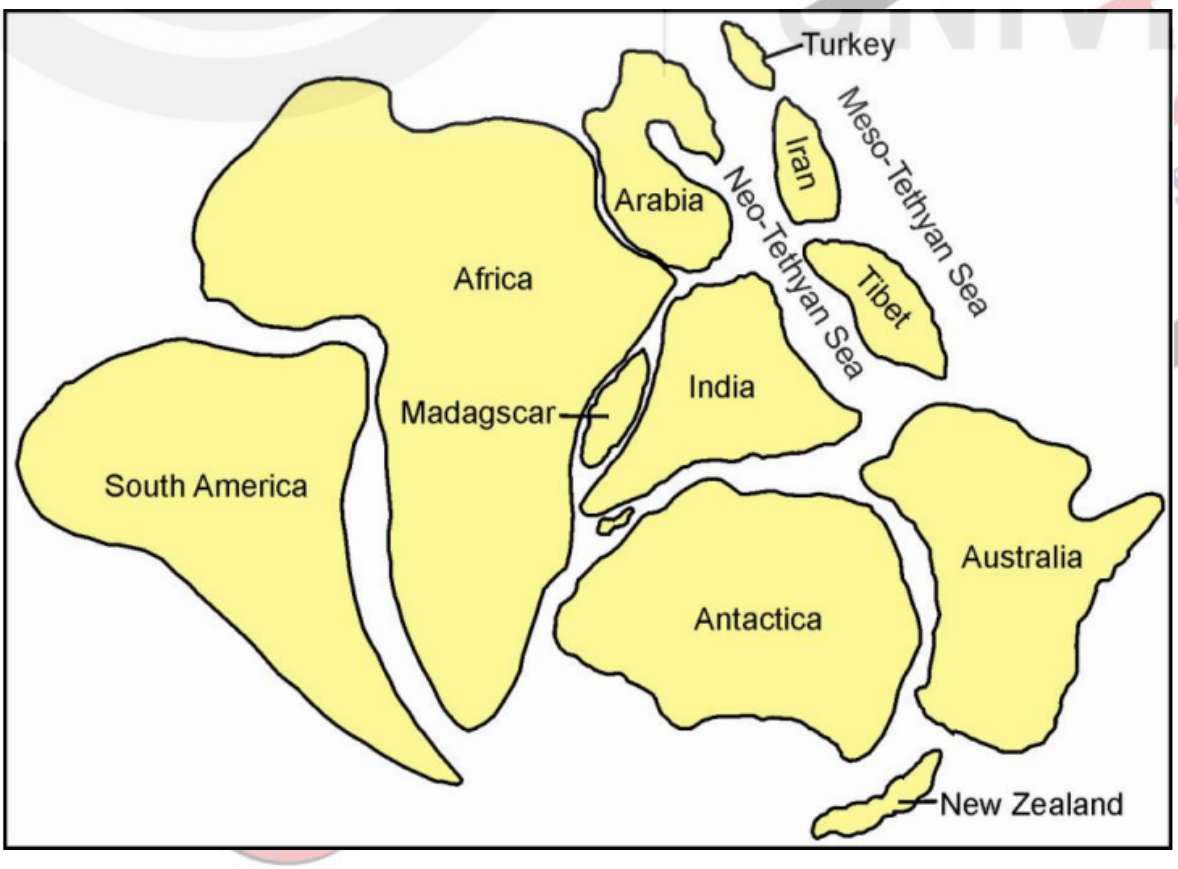
Economic Significance of Deccan Volcanism

- **Major Rocks: Basalt** is found in the Deccan Traps, and **granite and gneiss** is common in southern India, especially **Karnataka and Tamil Nadu.**
- **Mineral Resources: Iron ore** is abundant in **Karnataka**, and **bauxite** is found in the **Eastern Ghats.**
- **Agriculture:** It supports **cotton and tobacco** due to the presence of **Black soil.**
    - **Black soil** was formed from the **weathering of volcanic rocks**, particularly **basalt**, which is rich in minerals like iron, magnesium, calcium, and potassium.

Note: The Deccan Traps cover significant parts of **South India**, including large areas of **Maharashtra**, **Karnataka**, **Gujarat**, **Madhya Pradesh**, **Andhra Pradesh**, and **Tamil Nadu**, with smaller extensions into **Telangana** and **Kerala**.

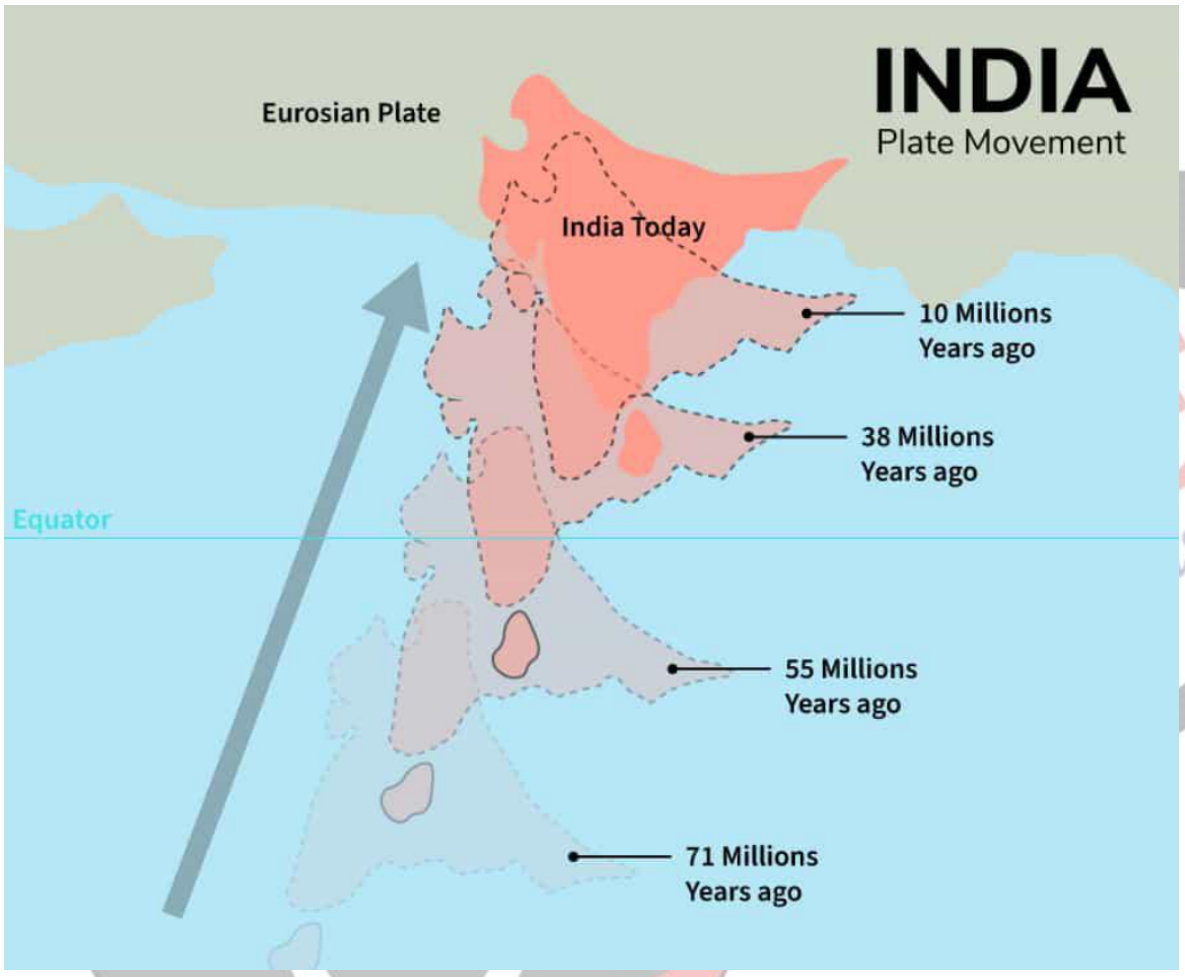
What are the Key Points on the Movement of the Indian Plate?

- **Breaking of Gondwanaland**: The Indian Plate was part of **Gondwanaland** along with **South America, Africa, Arabia, Madagascar, Australia, and Antarctica** in the Late Palaeozoic Era which began **breaking apart in the Late Triassic (~215 Ma) period**.
- The **Tethys Sea** separated India from the Eurasian plate till **about 225 million years ago.**



- **Separation and Drifting**: India separated from **Africa** in the **Middle Jurassic (~165-150 Ma)** and from **Antarctica-Australia** in the **Early Cretaceous (~130-120 Ma).**
    - The **Indo-Madagascar** block split from **Antarctica-Australia around 130-120 Ma,** and the **Seychelles** separated from India around the **Cretaceous-Paleocene boundary (~66 Ma).**
- **Rifting and Mantle Plumes**: Mantle plumes played a crucial role in the **rifting and drifting** of the Indian plate, with significant basaltic volcanic eruptions.
    - E.g., **Reunion mantle plume** separated the **Indian plate from Seychelles**, forming the Deccan traps.
- **Collision with Asia**: The **Indian plate collided with the Asian plate** during

the **Eocene** (~50-35 Ma ago), forming the **Himalayan mountain** range and **uplifting the Tibetan Plateau.**
    - As the Indian plate collided with Eurasian plate, the **Tethyan Sea was closed**.
- **Geological Impact**: The India-Asia collision is a hard **continent-continent collision** that resulted in the formation of the biggest and **youngest fold mountain belt** of the world known as **Himalaya.**
    - It significantly altered the global climate and established a **distinct monsoon system** for the Indian subcontinent.
    - Continent-continent collision occurs when **two continental plates collide,** forming large mountain ranges as both plates are **too buoyant to sink** into the mantle.



Conclusion

The study highlights the **resilience of tropical flora** during the Deccan Volcanism, which led to mass extinctions of fauna but **fostered diverse tropical ecosystems**. The Indian Plate's movement, combined with volcanic activity, played a significant role in shaping global biodiversity and the Earth's climate.

Drishti Mains Question:

Analyze the impact of the Indian Plate's movement on global biodiversity and climate.

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

Q. The term “sixth mass extinction/sixth extinction” is often mentioned in the news in the

context of the discussion of (2018)

(a) Widespread monoculture practices in agriculture and large-scale commercial farming with indiscriminate use of chemicals in many parts of the world that may result in the loss of good native ecosystems.

(b) Fears of a possible collision of a meteorite with the Earth in the near future in the manner it happened 65 million years ago that caused the mass extinction of many species including those of dinosaurs.

(c) Large scale cultivation of genetically modified crops in many parts of the world and promoting their cultivation in other parts of the world which may cause the disappearance of good native crop plants and the loss of food biodiversity.

(d) Mankind's over-exploitation/misuse of natural resources, fragmentation/loss of natural habitats, destruction of ecosystems, pollution and global climate change.

Ans: (d)

Q. The black cotton soil of India has been formed due to the weathering of (2021)

(a) brown forest soil

(b) fissure volcanic rock

(c) granite and schist

(d) shale and limestone

Ans: (b)

Mains

Q.Discuss the geophysical characteristics of Circum-Pacific Zone. **(2020)**

Q.Define mantle plume and explain its role in plate tectonics. **(2018)**

Q. Explain the formation of thousands of islands in Indonesian and Philippines archipelagos. **(2014)**