



# Hydrothermal Vents in Indian Ocean

[Source: IE](#)

## Why in News?

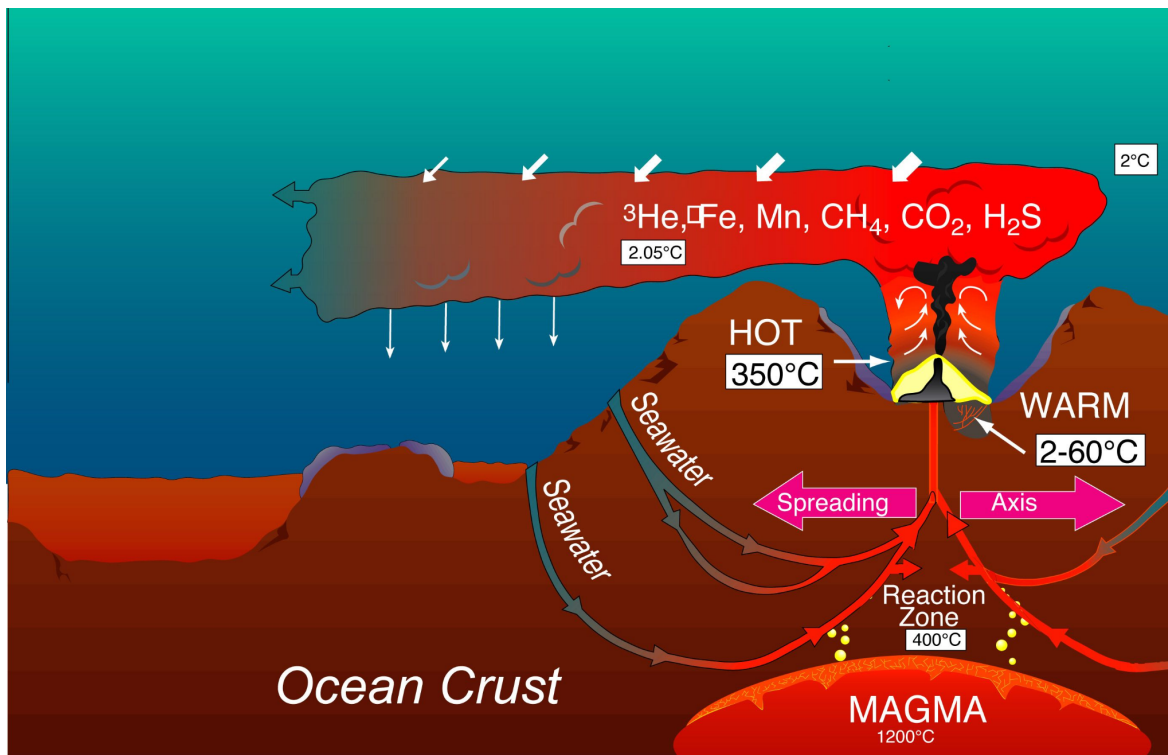
[India's Deep Ocean Mission](#) recently achieved a milestone by **imaging an active hydrothermal vent** 4,500 meters below the [Indian Ocean's surface](#).

- This breakthrough enhances India's mineral exploration and deep-sea research, offering significant potential for the [Samudrayaan mission](#) and future exploration efforts.

## What are Hydrothermal Vents?

- **Definition:** Hydrothermal vents are **underwater hot springs** found near the [tectonic plates](#), where **hot water and minerals** from beneath the Earth's crust are expelled into the ocean.
  - Hydrothermal vents were first discovered in 1977 near the **Galapagos Islands, Ecuador**.
- **Formation Process:** Seawater percolates down through **fissures** (cracks that form when tectonic plates spread apart) in the ocean crust near [tectonic plates](#) that are either moving apart (**spreading ridges**) or **moving towards one another (subduction zones)**.
  - The **cold seabed water (about 2°C)** comes into contact with **hot magma**, getting heated up to high temperatures (**370°C**).
  - The heated seawater reemerges from the ocean floor as **hydrothermal fluids**, forming the vents.
    - The seawater at hydrothermal vents can reach over 700°F but does not boil due to the **high pressure at the depths**.
- **Types of Hydrothermal Vents:**
  - **Black Smokers:** These vents emit **particle-laden fluids**, primarily **iron sulfides**, which form **black chimney-like structures**.
  - **White Smokers:** These vents emit fluids containing **barium, calcium, and silicon, forming white chimneys**.
- **Significance:** The deposits from hydrothermal venting are rich in **copper, zinc, gold, silver, platinum, iron, cobalt, nickel**, and other valuable minerals and metals.
  - Hydrothermal Vents create ecosystems where **chemosynthetic organisms** (organisms that rely on chemicals rather than sunlight for energy) thrive.
  - Hydrothermal vents, active for up to **30,000 years**, support long-term exploration and resource use.

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## Other Geothermal Features Similar to Hydrothermal Vents

- **Hot Springs:** Like hydrothermal vents, **hot springs on land** are areas where heated groundwater (heated by geothermal heat from **Earth's interior**) emerges at the surface.
  - In volcanic areas, water comes into contact with **hot rock heated by magma**, producing **superheated water**.
  - In non-volcanic areas, the **temperature of rocks increases with depth (Geothermal Gradient)**. Water percolates deep enough to come into contact with hot rocks, circulating to the **surface and forming hot springs**.
  - **Example:** Manikaran (Himachal Pradesh), Gaurikund (Uttarakhand)
- **Geysers:** These are geothermal features that periodically **eject water and steam due to underground heating**.
  - **Geysers** require large amounts of groundwater to fill underground cavities in volcanic areas. When heated by **nearby magma**, the **water flashes into steam**, causing an eruption of hot water and steam.
  - **Example: Yellowstone National Park (US).**
- **Fumaroles:** These are openings in the Earth's crust where volcanic gases and steam are released.
  - Fumaroles occur when **magma passes through the water table**, heating the water and causing steam to rise, carrying volcanic gases like **hydrogen sulfide ( $\text{H}_2\text{S}$ ) to the surface**.
  - Often found near "**dying volcanoes**" where magma deep underground has solidified and cooled.
  - **Example: Barren Island (Andaman and Nicobar Islands)**
- **Mudpots:** These are the bubbling pools of mud that form in geothermal areas.
  - Formed when limited geothermal water mixes with mud and clay.
  - **Example: Yellowstone National Park (US)**





Ministry of Earth Sciences  
Government of India

# DEEP OCEAN MISSION

EXPLORING THE DEEP OCEAN - THE FINAL FRONTIER ON PLANET EARTH

Oceans are the key to sustenance of life on our planet. They are the driving force for monsoons, flywheel of climate, vital source of natural resources and act as a trigger for ocean hazards. Oceans contribute immensely to "Blue Economy" through sectors such as Fisheries, Renewable Energy, Oil & Gas, Minerals, Shipping, Tourism, etc.

The lives and livelihoods of about 350 million population living along the 7500 km long coastline of India are intricately linked to the Oceans. Climate change and anthropogenic impacts are threatening ocean health and biodiversity. Yet, 95% of the deep ocean remains unexplored.

India's Deep Ocean Mission will contribute to our understanding of the oceans, realising our "Blue Economy" vision and managing our Oceans sustainably. Being undertaken at a cost of ₹4077 Crore over the next 5 years, the Mission will be spearheaded by the Ministry of Earth Sciences in synergy with other Central Ministries, National Institutions, Universities and Industry.

## Technologies for Autonomous Underwater Vehicles and Deep Sea Mining

Manned submersible capable of diving up to 6000 m to the bottom of the ocean.

Mining tools to explore 300 MMT of valuable metal deposits in a 75,000 square kilometre area in the Indian Ocean sea bed.



## Deep Ocean Survey and Exploration

Construction of a state-of-the-art research vessel to explore hydrothermal deposits in mid-ocean ridges for precious metals like Copper, Zinc, Aluminum, Silver, and Platinum, etc.



## Ocean Climate Change Advisory Services

Accurate future projection of sea level change and extreme events like cyclones, storm surges and waves to safeguard our coastal population, economy and infrastructure.

A suite of state-of-the-art ocean models and an improved network of ocean observations based on deep sea gliders, deep Argos, etc.



## Exploration and Conservation of Deep Sea Biodiversity

Inventorization of deep sea fauna and flora including microbes.

Products of Industrial importance from the deep-sea microbes.



Carnivorous Sponges

## Advanced marine station for Ocean Biology

Translate research in ocean biology and engineering into industrial application and product development through establishment of on-site business incubator facilities.



## Energy and freshwater from the Ocean

Engineering capabilities to scale up offshore Ocean Thermal Energy Conversion (OTEC) powered energy generation and desalination plant for clean energy and fresh water.

Read more: [Underwater Structures in the Indian Ocean](#)

UPSC Civil Services Examination, Previous Year Questions (PYQs)

Prelims

**Q. Consider the following: (2013)**

1. Electromagnetic radiation
2. Geothermal energy
3. Gravitational force
4. Plate movements
5. Rotation of the earth
6. Revolution of the earth

**Which of the above are responsible for bringing dynamic changes on the surface of the earth?**

- (a) 1, 2, 3 and 4 only  
(b) 1, 3, 5 and 6 only  
(c) 2, 4, 5 and 6 only  
(d) 1, 2, 3, 4, 5 and 6

**Ans: (d)**

**Explanation:**

- The Earth's surface is dynamic. The Earth's surface is being continuously subjected to by external forces (exogenic forces) originating above the earth's surface, mainly induced by the energy of the Sun and by internal forces (endogenic forces) from within the earth.
- Endogenic Processes
  - The energy emanating from within the earth is the main force behind endogenic geomorphic processes.
  - This energy is mostly generated by radioactivity, release of electromagnetic energy, rotational and tidal friction and primordial heat from the origin of the Earth.
  - This energy is due to geothermal gradients and heat flow from within the earth.
  - Endogenic process has induced volcanism and associated geothermal phenomena like geysers, hot water springs, etc.; earthquakes; plate movements resulting in the creation of different landforms (mountains, hills, plateaus, etc.) and water bodies (sea, ocean, lake, etc.).
- Exogenic Processes
  - The exogenic processes derive their energy from atmosphere determined by the ultimate energy from the Sun, e.g., weathering and erosion.
  - Temperature and precipitation are the two important climatic elements that control various processes.
- Seasonal and diurnal variation on Earth is due to revolution and rotation of Earth respectively.
- **Therefore, option (d) is the correct answer.**