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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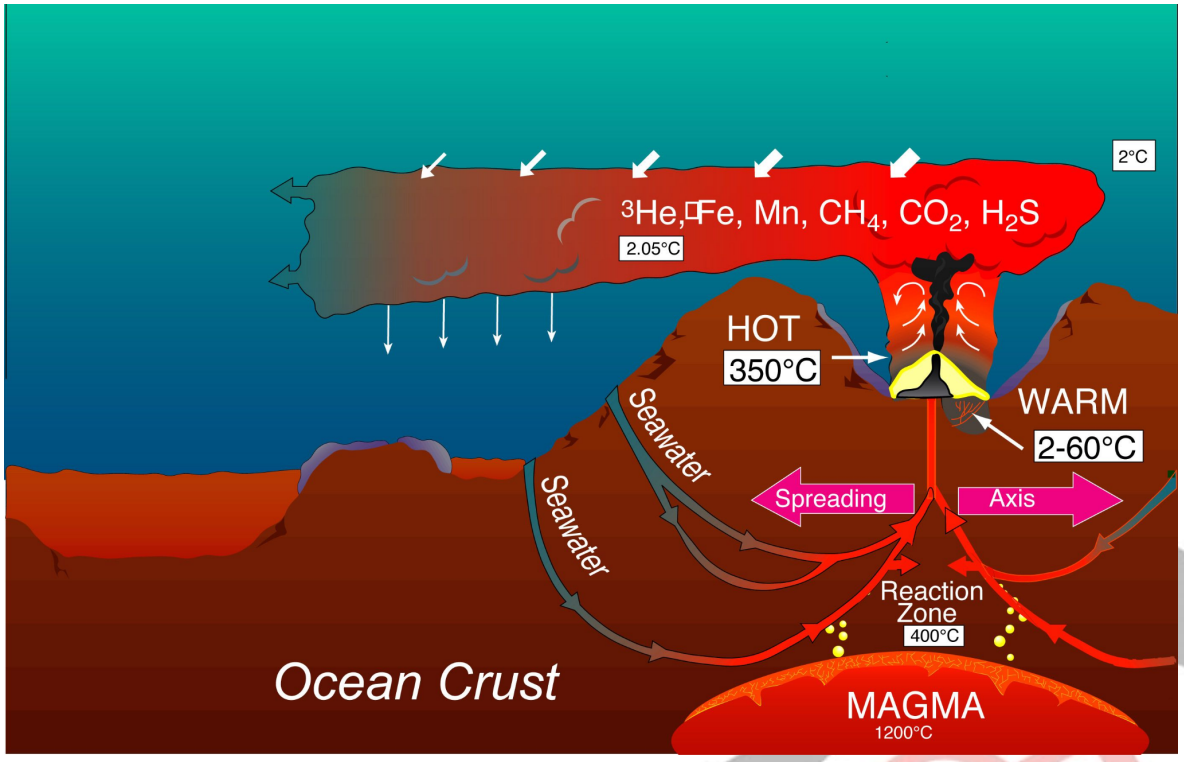

Other Geothermal Features Similar to Hydrothermal Vents

- **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 (H_2S) 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)**

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.**