



Volcanic Eruption and Ionospheric Disturbances

[Source: PIB](#)

Why in News?

Recently, a new study revealed a **connection** between the [Tonga volcano eruption](#) and the formation of [Equatorial Plasma Bubbles \(EPBs\)](#) over the Indian subcontinent.

- Tonga volcano is a [submarine volcano](#) in the South Pacific Ocean.

What are the Key Highlights of the Study?

- **Volcanic Eruption and Space Weather:** The Tonga eruption triggered **ionospheric disturbances**, contributing to space weather events that affect **satellite signals**.
- **Atmospheric Gravity Waves:** The eruption produced strong [atmospheric gravity waves](#) that propagated into the upper atmosphere triggering favourable ionospheric conditions for the formation of EPBs.
 - Atmospheric gravity waves form when **buoyancy pushes air upward, and gravity pulls it back down**.
- **Plasma Instabilities: Plasma blobs**, an increase in the ionospheric eastward **electric field at dusk** were detected, indicating further ionospheric disturbances due to the eruption.

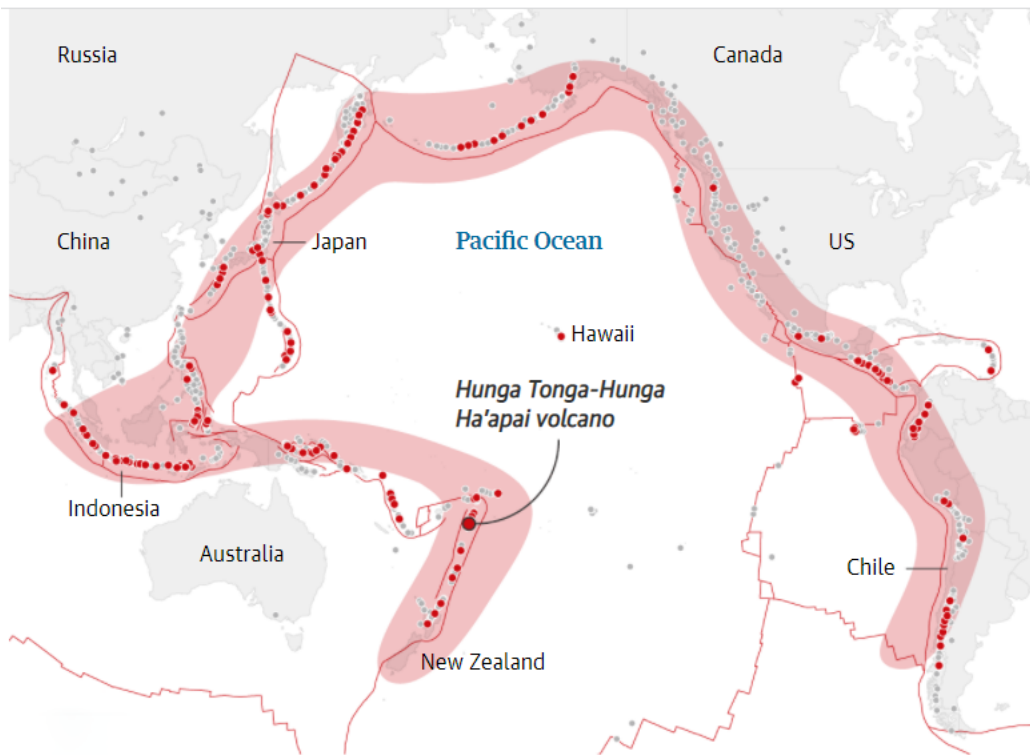
What are Key Points about Equatorial Plasma Bubbles (EPBs)?

- **About EPBs:** EPBs are ionospheric phenomena that are generated through **plasma instabilities**, particularly in the equatorial [ionosphere](#).
 - EPBs are regions of **depleted plasma** in the ionosphere that form near the **magnetic equator** during post-sunset hours.
 - EPBs originate in the equatorial ionosphere but can **extend**, affecting the global ionosphere **15° North and South of the Earth's equator**.
- **Impact on Radio Wave Propagation:** As radio waves propagate through the ionosphere, irregularities associated with EPBs can **scatter them, leading to signal degradation**.
 - It is a major concern for communication systems that rely on **high-frequency radio waves**, such as satellite communications and GPS.
- **Seasonal and Regional Variability:** EPBs are most frequent during the [Winter solstice](#) (21st or 22nd December) and **least frequent during the Summer solstice** (21st June).

What are Key Facts About the Tonga Volcano?

- **Location:** It is located in the **western South Pacific Ocean**, west of the main inhabited islands in the Kingdom of **Tonga**.
- **Geology:** It is one of 12 confirmed submarine volcanoes along the [Tofua Arc](#), a segment of the larger **Tonga-Kermadec volcanic arc**.
 - The **Tonga-Kermadec arc** formed as a result of subduction of the [Pacific Plate](#) beneath the **Indo-Australian Plate**.
 - It is a part of the [Ring of Fire](#).

- **Submarine Volcano:** It is an **undersea Volcano** consisting of two small uninhabited islands, **Hunga-Ha'apai** and **Hunga-Tonga**.



VOLCANOES

A volcano is a vent or a fissure in the crust from which lava (molten rock), ash, gases, rock fragments erupt from a magma chamber below the surface

- **Types: On basis of -**
 - **Periodicity of Eruption:**
 - **Active volcano:** Recently Erupted
 - **Dormant Volcano:** Potential for eruption, no imminent signs
 - **Extinct:** No recent eruptions, low possibility in future
 - **Nature of Eruption:**
 - **Hawaiian:** Calmest types (low gaseous content)
 - **Strombolian:** Formation of large gas bubbles in magma
 - **Vulcanian:** More explosive
 - **Plinian eruptions:** Magma's volatile gases rise via a narrow conduit
 - **Icelandic:** Often build lava plateaus
 - **Shape of Volcanoes:**
 - **Shield volcanoes:** Composed of basaltic lava, low slope
 - **Cone volcanoes (Cinder Cones):** Most abundant
 - **Composite cones (stratovolcanoes):** Formed by layers of diverse materials.
- **Volcanic Features:**
 - **Extrusive :**
 - **Crater:** Cone-shaped vent for magma
 - **Caldera:** Large, crater-like depression
 - **Volcanic Plateaus:** Leveled areas from fissure eruptions

- **Intrusive:**
 - **Batholiths:** Central core of a volcanic mountain.
 - **Dyke:** Vertical intrusion cutting across country rock bedding.
 - **Sills:** Tabular intrusions along sedimentary bedding.
 - **Laccoliths:** Magma injection along horizontal sedimentary bedding.
- **Minor:**
 - **Geysers:** Underground water above 100°C, powered by magma, results in powerful eruptions with steam and diluted minerals.
 - **Hot Springs:** Heated water flows quietly along fault zones.
- **Distribution of Volcanoes:**
 - Subduction zones (Circum Pacific Belt)
 - Divergence zones (Mid Atlantic Ridge)
 - Intra-plate oceanic volcanism (Hawaiian chain)
 - Mid-continental belt and volcanoes in Mediterranean region
- **Volcanoes in India:**
 - No volcanoes in Himalayas
 - Barren Island (Only active volcano)
- **Products of Volcanic Eruption:**
 - **Gases:** H, C, O, S, N, CH₄, NH₃
 - **Solid:** Pyroclastic materials
 - **Liquid:** Lava

Ionosphere

- It is **not a distinct layer** like the Troposphere or Stratosphere. Instead, the ionosphere **overlaps** the **mesosphere, thermosphere, and exosphere**.
- It's a very **active part** of the atmosphere, and it **grows and shrinks** depending on the energy it absorbs from the sun.
 - It is an **electrically conducting region** capable of **reflecting radio signals** back to Earth.
- The **electrically charged atoms and molecules** that are formed in this way are called **ions**, giving the ionosphere its name.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q.Consider the following statements: (2018)

1. The Barren Island volcano is an active volcano located in the Indian territory.
2. Barren Island lies about 140 km east of Great Nicobar.
3. The last time the Barren Island volcano erupted was in 1991 and it has remained inactive since then.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 and 3
- (c) 3 only
- (d) 1 and 3

Ans: (a)

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)