

Over 1,000 Earthquakes Struck Japan's Tokara Islands

The seismic swarm of over 1,000 earthquakes in Japan's Tokara Islands during June and July 2025 was caused by volcanic and tectonic activity where the Philippine Sea and Eurasian plates interact. The geological stress was likely exacerbated by the movement of magma beneath the islands.

Key details of the earthquake swarm

- **Intense and unusual activity:** The swarm began on June 21, and its pace was unusually high and long-lasting compared to previous seismic activity in the region.
- **Peak intensity:** The strongest quake in the sequence, a magnitude 5.5, occurred on July 3, reaching a "6-lower" on Japan's seven-stage Shindo seismic intensity scale on Akusekijima island.
- **Widespread fear:** The constant shaking made it difficult for residents to sleep and led to anxiety about a potential larger earthquake.
- **Evacuation orders:** Local authorities ordered evacuations for residents of Akusekijima, which has a population of about 90, beginning on July 4. Voluntary evacuations were also conducted from other islands.
- **Minimal damage:** Despite the intensity of the shaking, no major injuries or structural damage were reported. The quakes caused some rockfalls, landslides, and minor road cracks.
- **Ground movement detected:** Researchers detected that two small islands, Kodakara and Takara, shifted apart by nearly 10 centimeters in just three days in early July. This is an unusual movement, as the islands typically move in the same direction.

Geological context and Causes

- **Magma movement:** Experts believe the swarm is linked to volcanic activity in the region. The islands sit in the volcanically active Pacific Ring of Fire, and the movement of magma or underground fluids can create pressure that causes fault lines to fracture.
- **Tectonic plate interaction:** The islands are located where the Philippine Sea plate subducts under the Eurasian plate, leading to significant seismic activity.

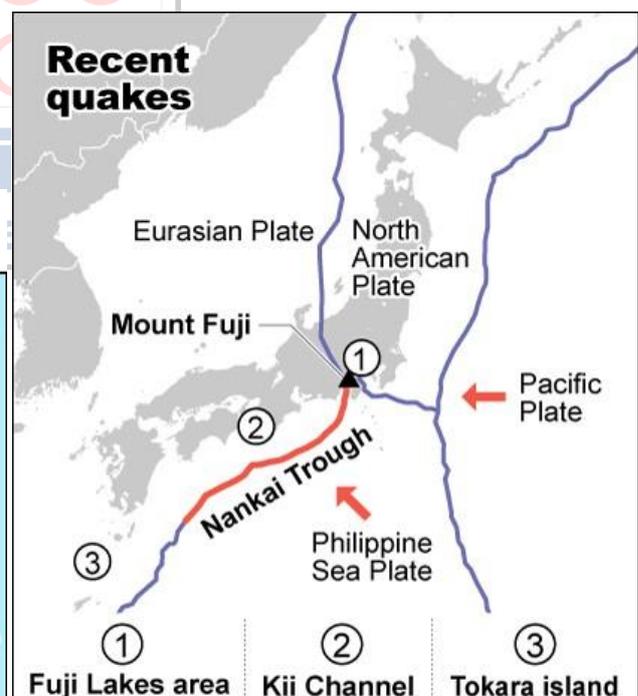
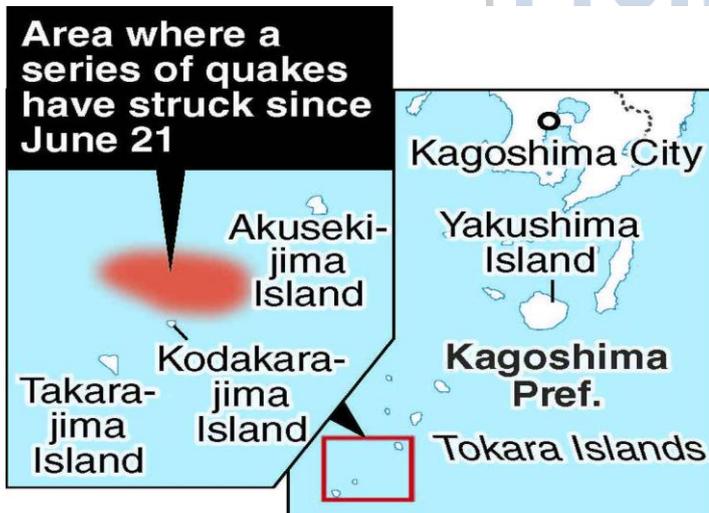
- **Unrelated to megaquake risk:** Seismologists emphasized that this localized swarm was not related to the long-anticipated and more dangerous "megaquake" expected along the Nankai Trough hundreds of kilometers away.

Explanation of Exam Oriented Key Terms

01

Geographical context of Tokara Islands

- **Location:** The Tokara Islands are a small volcanic chain in the Ryukyu archipelago, situated south of Kyushu, Japan, between the East China Sea and the Pacific Ocean.
- **Ring of Fire:** The islands' location places them within the Pacific "Ring of Fire," a major horseshoe-shaped zone of frequent earthquakes and volcanic eruptions.
- **Tectonic Plate Boundary:** The seismic activity is driven by the interaction of several major tectonic plates, including the Philippine Sea and Eurasian Plates.
- **Volcanic Archipelago:** The Tokara island chain is a volcanic arc, with active volcanoes like Mount Otake on Nakanoshima Island. This volcanic origin is a key factor in the region's seismicity.



02

Earthquake Swarm

An earthquake swarm is a series of mostly low-magnitude earthquakes with no mainshock, occurring over days to months in a concentrated area due to fluid movement, active volcanism, tectonic activity, slow-slip events, or human-induced factors like wastewater injection or mining.

Causes of Earthquake Swarms

- **Fluid Movement:** The movement of fluids, like magma or hydrothermal fluids, can lubricate faults, creating small seismic events.
- **Active Volcanism:** Magma movement beneath the surface can create stress, fracturing the crust and leading to swarm activity.
- **Slow-Slip Events:** Gradual, slow-motion movement along a fault over weeks or years can trigger swarms.
- **Tectonic Activity:** Stress accumulated along fault lines can be released in small increments, causing swarms.
- **Induced Seismicity:** Human activities such as wastewater injection, geothermal energy extraction, and mining can trigger swarms.

Characteristics of Earthquake Swarms

- **No Clear Mainshock:** A defining feature is the lack of a single, dominant earthquake.
- **Duration:** Swarms can be short, lasting hours, or extended, continuing for days, weeks, or months.
- **Frequent Occurrence:** Many small to moderate earthquakes happen in a localized area over a short period.
- **Variable Magnitude:** While most quakes are small, swarms can occasionally include larger events.
- **Concentrated Area:** Earthquakes are confined to a specific, localized region.
- **Acoustic Emissions:** Some swarms may be accompanied by sounds or sound disturbances.

Evidence of earthquake swarms

1. Volcanic and magmatic regions

- Antarctica (Bransfield Strait)
- Canary Islands (El Hierro)

- Iceland (Krafla)
- Japan (Noto Peninsula)
- United States (Yellowstone Caldera)

2. Continental rift zones

- East Africa (Main Ethiopian Rift)
- Czech Republic/Germany (Western Bohemia/Vogtland)
- Mayotte (Indian Ocean)

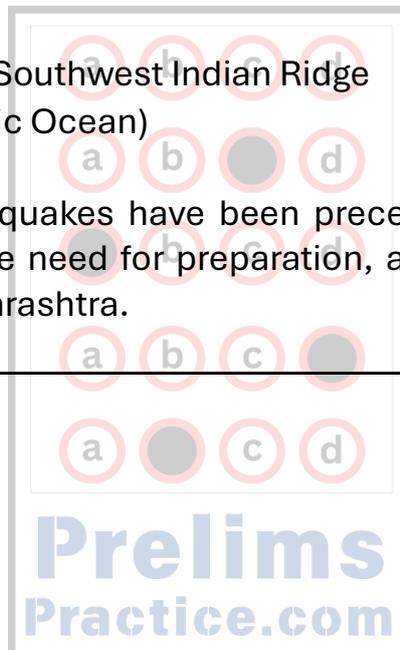
3. Subduction zones and tectonic faults

- Chilean Subduction Zone
- India (Palghar and other areas)
- Philippines (Batangas)

4. Mid-ocean ridges

- Arctic Ridge and Southwest Indian Ridge
- Galapagos (Pacific Ocean)

In some regions, large earthquakes have been preceded by swarm activity, raising concerns and highlighting the need for preparation, as seen in the Koyna and Latur earthquake incidents in Maharashtra.



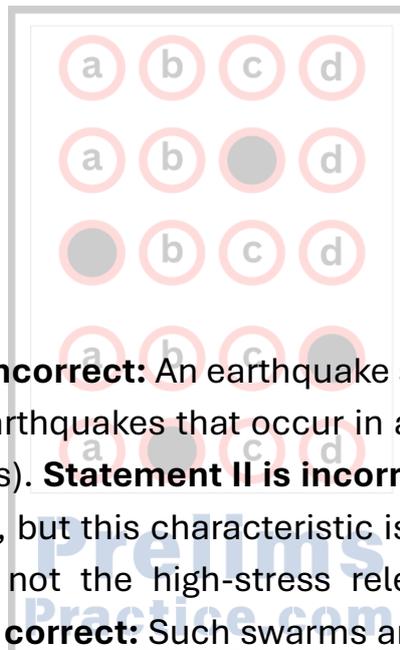
Practice Questions:

1. With reference to "earthquake swarms" like the one observed in the Tokara Islands, consider the following statements:

- I. An earthquake swarm is a series of high-magnitude earthquakes occurring over a long period in a concentrated area
- II. The 2025 Tokara swarm was characterized by an exceptionally low magnitude scale, a feature consistent with typical tectonic stress release
- III. Earthquake swarms are often observed during periods of active volcanic activity.

Which of the statements given above is/are correct?

- a) I and II only
- b) III only
- c) I and III only
- d) I, II and III



Answer: b

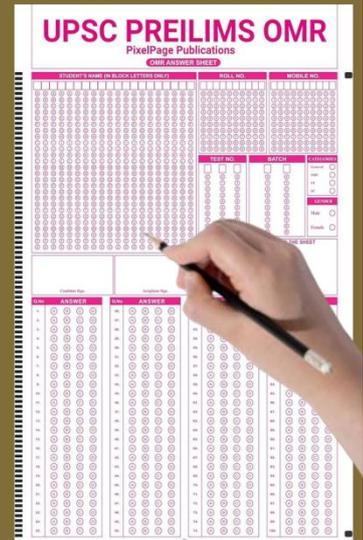
Explanation: Statement I is incorrect: An earthquake swarm is defined as a sequence of generally low-magnitude earthquakes that occur in a localized area over a relatively short duration (days to months). **Statement II is incorrect:** The 2025 Tokara swarm did exhibit a low magnitude scale, but this characteristic is consistent with magma-driven (volcanic-related) seismicity, not the high-stress release typical of major tectonic earthquakes. **Statement III is correct:** Such swarms are frequently observed following major seismic events or, more commonly, during periods of active volcanic activity, as seen with the 2000 Miyake Island eruption and the 2021/2025 Tokara events.

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