NO PREP

Geological Hazards

Tsunamis, Undersea Earthquakes, and Landslides

Includes: Student reading, case study, differentiated questions, teacher key

Name: Period: Date:

Geological Hazards: Tsunamis, Undersea Earthquakes, and Landslides

The Dangers of the Ocean Floor

The ocean hides powerful forces beneath its surface. Geological hazards such as tsunamis, undersea earthquakes, and submarine landslides occur when Earth's crust shifts or collapses beneath the sea. These events can devastate coastlines, destroy infrastructure, and take thousands of lives. While they are natural processes, studying these hazards helps scientists develop early-warning systems and improve community preparedness. Marine geology plays a critical role in predicting and understanding these events because the triggers often originate deep below the seafloor where direct observation is difficult.

Undersea Earthquakes

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Undersea Earthquakes

Most undersea earthquakes occur along plate boundaries, where tectonic plates collide, slide, or pull apart. When stress builds up and releases suddenly, seismic waves spread through the ocean crust. If the seafloor shifts vertically, it can displace massive volumes of water, generating a tsunami. Not all undersea earthquakes create tsunamis, but even without them, earthquakes can disrupt seafloor ecosystems, damage undersea cables, and trigger landslides. The most powerful earthquakes occur at subduction zones, where one plate dives beneath another.

Tsunamis

A tsunami is a series of long, powerful waves caused by sudden water displacement. Unlike ordinary waves, which are driven by wind, tsunamis can travel across entire oceans at jetliner speeds. As they approach shallow coastal areas, their energy compresses, causing wave heights to increase dramatically. Tsunamis can be caused

by earthquakes, volcanic eruptions, or landslides. Early warning systems, which rely on seismic sensors and ocean buoys, are crucial for saving lives. Even with warning, evacuation requires rapid response because the time between an earthquake and tsunami landfall may be only minutes.

Submarine Landslides

Submarine landslides occur when large amounts of sediment collapse down continental slopes. These landslides can be triggered by earthquakes, volcanic eruptions, or even rapid sediment buildup. Like earthquakes, they can generate tsunamis if enough water is displaced. The Grand Banks landslide of 1929, caused by an earthquake off Newfoundland, not only damaged undersea cables but also created a deadly tsunami that struck the coast of Canada. Such events show that landslides beneath the ocean can be as destructive as those on land.

Key Information: Table: Types of Geological Hazards

Hazard	Cause	Effects	Example
Undersea earthquake	Tectonic plate movement	Seafloor shaking, tsunamis, cable damage	2004 Indian Ocean earthquake
Tsunami	Displacement of water by quake, volcano, or landslide	Coastal flooding, destruction, loss of life	Sumatra 2004, Japan 2011
Submarine landslide	Collapse of sediments on continental slope	Tsunamis, cable breaks, seafloor reshaping	Grand Banks 1929

Case Study: The 2004 Indian Ocean Earthquake and Tsunami

On December 26, 2004, one of the deadliest natural disasters in history struck the Indian Ocean region. A magnitude 9.1 earthquake ruptured off the coast of Sumatra, Indonesia, along a subduction zone. The sudden movement displaced an enormous volume of water, creating a series of massive tsunamis. Waves up to 30 meters high struck Indonesia, Sri Lanka, India, and Thailand. More than 230,000 people died across 14 countries. Entire communities were destroyed, and millions were displaced. Scientists later confirmed that the earthquake rupture extended for more than 1,000 kilometers along the seafloor. This tragedy highlighted the urgent need for international tsunami warning systems, many of which were implemented in the years following the disaster.

1. How did the 2004 Indian Ocean earthquake generate a tsunami?

_____

_____

2. What steps did the disaster inspire to help protect coastal communities?

_____

_____

Multiple Choice

1. What primarily causes tsunamis?

    a) Ocean currents

    b) Wind over the ocean

    c) Sudden displacement of seawater

    d) Tidal forces from the Moon's gravitational pull

2. Which type of plate boundary is most likely to generate powerful undersea earthquakes?

a) Subduction zone

b) Transform boundary

c) Hotspot boundary

d) Divergent boundary

3. Which event inspired the creation of international tsunami warning systems?

a) Grand Banks landslide

b) 2010 Chile earthquake along the Pacific coast

c) 1923 Tokyo earthquake

d) 2004 Indian Ocean earthquake and tsunami

Matching

Write the letter of the correct definition on the line next to each term.

Term	Definition
1. ___ Undersea earthquake	A) Triggered by seafloor displacement of water
2. ___ Tsunami	B) Earthquake-triggered slide causing tsunami
3. ___ Submarine landslide	C) Inspired new global warning systems
4. ___ 2004 Indian Ocean event	D) Collapse of sediment on continental slope
5. ___ Grand Banks 1929	E) Caused by tectonic stress release

Fill-in-the-Blank

1. A _____ is a massive wave caused by sudden displacement of seawater.

2. The 2004 Indian Ocean earthquake occurred at a _____ zone.

3. Submarine _____ can generate tsunamis by collapsing large amounts of sediment.

Short Answer

Answer each question in 2-4 complete sentences.

1. Why are tsunami waves so destructive compared to regular ocean waves?

2. How can submarine landslides disrupt human activity beyond causing tsunamis?

3. What role does marine geology play in reducing the impact of geological hazards?