WHAT CAU

Tsunamis, also called seismic sea wave or incorrectly tidal waves, are caused generally by earthquakes, less commonly by submarine landslides, infrequently by submarine volcanic eruptions and very rarely by large meteorite impacts in the ocean. Submarine volcanic eruptions have the potential to produce truly awesome tsunami waves. The Great Krakatau Volcanic Eruption of 1883 generated giant waves reaching heights of 40 meters above sea-level, killing more than 30,000 people and wiping out numerous coastal villages.

All oceanic regions of the world can experience tsunamis, but in the Pacific Ocean and it's marginal seas, there is a much more frequent occurrence of large, destructive tsunamis because of the many large earthquakes along the margins of the Pacific Ocean.

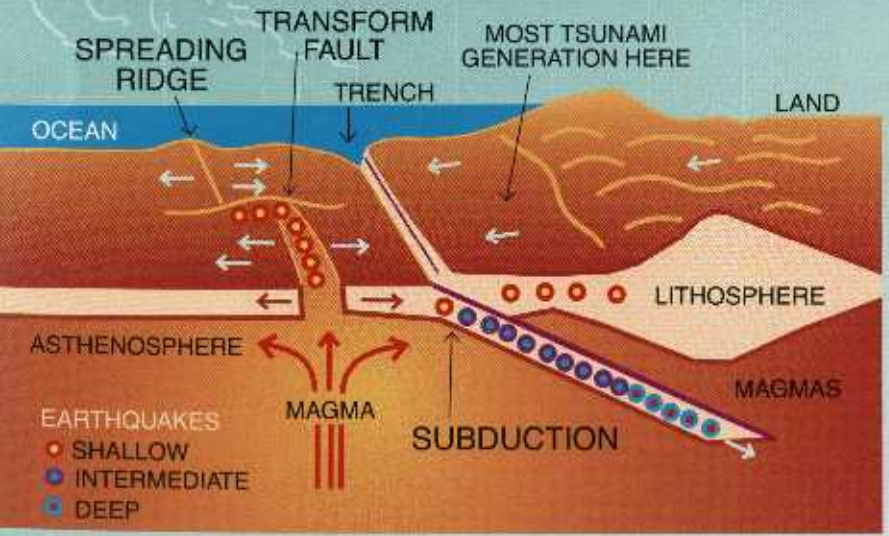

PLATE TECTONICS

Plate Tectonic theory is based on an earth model characterized by a small number of lithospheric plates, 70 to 250 km (40 to 150 mi) thick, that float on a viscous underlayer called the asthenosphere. These plates, which cover the entire surface of the earth and contain both the continents and seafloor, move relative to each other at rates of up to ten cm/year (several inches/year). The region where two plates come in contact is called a plate boundary, and the way in which one plate moves relative to another determines the type of boundary: spreading, where the two plates move away from each other; subduction, where the two plates move toward each other and one slides beneath the other; and transform, where the two plates slide horizontally past each other. Subduction zones are characterized by deep ocean trenches, and the volcanic islands or volcanic mountain chains associated with the many subduction zones around the Pacific rim are sometimes called the Ring of Fire.

EARTHQUAKES AND TSUNAMIS

An earthquake can be caused by volcanic activity, but most are generated by movements along fault zones associated with the plate boundaries. Most strong earthquakes, representing 80% of the total energy released worldwide by earthquakes, occur in subduction zones where an oceanic plate slides under a continental plate or another younger oceanic plate.

Not all earthquakes generate tsunamis. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and cause vertical movement of the seafloor (up to several meters) over a large area (up to a hundred thousand square kilometers). Shallow focus earthquakes (depth less 70 km or 42 mi) along subduction zones are responsible for most destructive tsunamis. The amount of vertical and horizontal motion of the sea floor, the area over which it occurs, the simultaneous occurrence of slumping of underwater sediments due to the shaking, and the efficiency with which energy is transferred from the earth's crust to the ocean water are all part of the tsunami generation mechanism.

Tsunami generated by May 26, 1983, Japan Sea earthquake approaching Okushiri Island, Japan. The runup here was 5.9 m (19 ft), but runups as high as 14 m (45 ft) were measured in Akita Prefecture 100 km east of the epicenter. Altogether, 100 people lost their lives, including three people in South Korea where the wave arrived about 1.5 hours after the earthquake. (Tokai Univ. report)

SES TSUNAMI?

TSUNAMI EARTHQUAKES

The September 2, 1992 earthquake (magnitude 7.2) was barely felt by residents along the coast of Nicaragua. Located well off-shore, its intensity, the severity of shaking on a scale of I to XII, was mostly II along the coast, and reached III at only a few places. Twenty to 70 minutes after the earthquake occurred, a tsunami struck the coast of Nicaragua with wave amplitudes 4 m (13 ft) above normal sea level in most places and a maximum runup height of 10.7 m (35 ft). The waves caught coastal residents by complete surprise and caused many casualties and considerable property damage.

This tsunami was caused by a tsunami earthquake — an earthquake that produces an unusually large tsunami relative to the earthquake magnitude. Tsunami earthquakes are characterized by a very shallow focus, fault dislocations greater than several meters, and fault surfaces that are smaller than for a normal earthquake.

They are also slow earthquakes, with slippage along the fault beneath the sea floor occurring more slowly than it would in a normal earthquake. The only known method to quickly recognize a tsunami earthquake is to estimate a parameter called the seismic moment using very long period seismic waves (more than 50 seconds / cycle). Two other destructive and deadly tsunamis from tsunami earthquakes have occurred in recent years in Java, Indonesia (June 2, 1994) and Peru (February 21, 1996).

El Tranisto, Nicaragua, September 1, 1992. Nine-meter high waves destroyed the town, killing 16 and injuring 151 in this coastal community of 1,000 people. The first wave was thought to be small providing time for people to escape the destructive second and third waves. More than 40,000 people were affected by the loss of their homes or means of income. (Harry Yeh, Univ. of Washington)

The earthquake focus is the point in the earth where the rupture first occurs and where the first seismic waves originate. The epicenter is the point on the Earth's surface directly above the focus.

The magnitude is the logarithm of the maximum amplitude of one the seismic waves (P, S, Rayleigh or Love surface waves) recorded by the seismometer; an increase in one unit of magnitude corresponds to a factor of 10 increase in amplitude.

TSUNAMI: THE RELATION WITH THE SEISMIC SOURCE