GEOLOGY

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Academic Script

INTRODUCTION

An earthquake is a natural phenomena , like other disaster Earthquakes affect almost every part of the Earth they can be mild or catastrophic.For the past millions years of geological history , earthquakes,floods, and other natural events have helped to shape the surface of our planet.An earthquake may last only a few seconds, but theprocesses that cause earthquakes have operated within the Earth for millions and millions of years. Until very recently, the cause of earthquakes was an unsolved mystery. It was the subject of fanciful folklore and equally fanciful learned speculation by peoples throughout the world.An earthquake is a sudden, rapid shaking of the Earth caused by the release of energy stored in rocks. This is a brief definition which students of all ages can master. A full definition of the term, however,would need to include a good deal oreinformation.Students may be surprised that we speak of rocksand rock layers, because in many places the rockmaterial of the Earth’s crust is covered by accumulationsof sand or soil. Remind them that even beneaththe sediment in river valleys, plains, and beachareas, some kind of rock is always present.Tectonic disturbances in the Earth’s crust result in the sudden release of energy that creates seismic waves. It may also refer to sudden and violent shaking of the ground, sometimes causing great destruction.

EPICENTER OF AN EARTHQUAKE

The point where the rocks actually break is the earthquake focus. Large subduction zone earthquakes can break along a fault for hundreds of kilometer. The epicenter of these earthquakes is directly above where the earthquake actually started along the fault line.
The amount of destruction at the epicenter of an earthquake is directly affected by its size and the depth where the rocks rupture. The epicenter of an earthquake is the same whether the rocks ruptured at 50 kilometers, 100 kilometers or even 300 kilometers beneath the Earth's surface.

STUDYING EPICENTERS

Seismologists use seismographs to study the earthquake epicenter. Using these epicenters they can discover the location of unknown faults and crustal plate boundaries.
Scientists are especially concerned about epicenters of past large earthquakes in cities like Tokyo, Japan and Los Angeles, California. Both of these cities are located in major fault zones.
The epicenter of the 1994 Northridge earthquake was in a large urban area and caused four billion dollars in damage. Prior to the earthquake scientists did not even know the fault existed and no small tremors gave warning of the impending disaster.

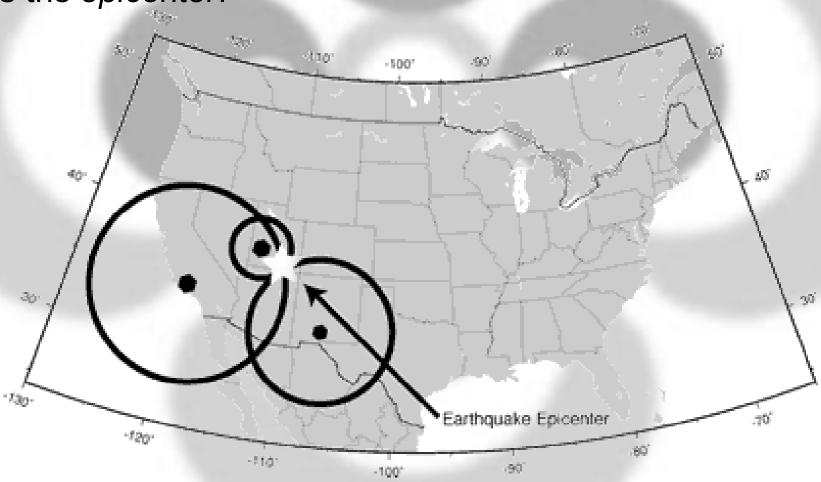
FOCUS OF AN EARTHQUAKE

Earthquakes with a focus of less than 70 kilometers are the most destructive. Therefore, when listening to earthquake reports it is important to know the geographic location of the earthquake listed as the epicenter and the depth of the earthquake.

HOW TO LOCATE AN EARTHQUAKE'S EPICENTER

The epicenter of an earthquake is the area on the surface directly above the focus of an earthquake. By locating the epicenter seismologist can determine where in the earth's surface the earthquake waves originate from. This will help predicting and preparing for future quakes and hazards. To locate the earthquake's epicenter you need a seismogram from three separate seismic stations. Study the seismographs and find the elapsed time between the arrival of the first P-wave and the first S-wave. By determining the S-P time, and using a time-distance graph you can find the distance to the epicenter from the seismic station. Now on a map draw a circle around the epicenter, in which the radius of the circle equals the distance to the epicenter. Draw circles around the other two seismic stations. the point at which the three circles meet is the epicenter. In a effort to get accurate earthquake readings the U.S. has created a world wide network of over 100 seismic stations, operated through Golden, Colorado. The largest station located in Billings, Montana, has 525 instruments grouped in 21 clusters covering a region of 200 k. in diameter. By using information from the instruments in Billings, seismologist using high-speed computers are able to locate an epicenter by a trial-and -error procedure

Scientists use a method called *triangulation* to determine exactly where the earthquake was. It is called triangulation because a triangle has three sides, and it takes three seismographs to locate an earthquake. If you draw a circle on a map around three different seismographs where the *radius* of each is the distance from that station to the earthquake, the intersection of those three circles is the *epicenter*!



TYPES OF EARTH QUAKES

They are of three types- Shallow, intermediate and deep foci earth quakes
Most parts of the world experience at least occasional shallow earthquakes—those that originate within 60 km (40 miles) of the Earth’s outer surface. In fact, the great majority of earthquake foci are shallow. It should be noted, however, that the geographic distribution of smaller earthquakes is less completely determined than more severe quakes, partly because the availability of relevant data is dependent on the distribution of observatories.
Of the total energy released in earthquakes, 12 percent comes from intermediate earthquakes—that is, quakes with a focal depth ranging from about 60 to 300 km. About 3 percent of total energy comes from deeper earthquakes. The frequency of occurrence falls off rapidly with increasing focal depth in the intermediate range. Below intermediate depth the distribution is fairly uniform until the greatest focal depths, of about 700 km (430 miles), are approached.
The deeper-focus earthquakes commonly occur in patterns called Benioff zones that dip into the Earth, indicating the presence of a subducting slab. Dip angles of these slabs average about 45°, with some shallower and others nearly vertical. Benioff zones coincide with

tectonically active island arcs such as Japan, Vanuatu, Tonga, and the Aleutians, and they are normally but not always associated with deep ocean trenches such as those along the South American Andes. Exceptions to this rule include Romania and the Hindu Kush mountain system. In most Benioff zones, intermediate- and deep-earthquake foci lie in a narrow layer, although recent precise hypocentral locations in Japan and elsewhere show two distinct parallel bands of foci 20 km apart.

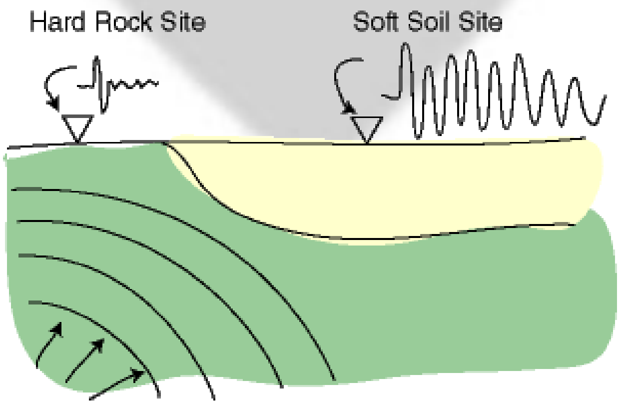
Geologic Effects on Shaking

EFFECTS OF EARTH QUAKE

Direct Shaking Hazards and Human-Made Structures

Most earthquake-related deaths are caused by the collapse of structures and the construction practices play a tremendous role in the death toll of an earthquake. In southern Italy in 1909 more than 100,000 people perished in an earthquake that struck the region. Almost half of the people living in the region of Messina were killed due to the easily collapsible structures that dominated the villages of the region. A larger earthquake that struck San Francisco had killed fewer people (about 700) because building construction practices were different type (predominantly wood). Survival rates in the San Francisco earthquake was about 98%, that in the Messina earthquake was between 33% and 45%) (Zebrowski, 1997). Building practices can make all the difference in earthquakes, even a moderate rupture beneath a city with structures unprepared for shaking can produce tens of thousands of casualties.
Although probably the most important, direct shaking effects are not the only hazard associated with earthquakes, other effects such as landslides, liquefaction, and tsunamis have also played important part in destruction produced by earthquakes.

When we discussed earthquake intensity we discussed some of the basic actors that affect the amplitude and duration of shaking produced by an earthquake (earthquake size, distance from fault, site and regional geology, etc.) and as you are aware, the shaking caused by seismic waves can cause damage buildings or cause buildings to collapse. The level of damage done to a structure depends on the amplitude and the duration of shaking. The amplitudes are largest close to large earthquakes and the duration generally increases with the size of the earthquake (larger quakes shake longer because they rupture larger areas). Regional geology can affect the level and duration of shaking but more important are local site conditions. Although the process can be complicated for strong shaking, generally shaking in soft sediments is larger and longer than when compared with the shaking experienced at a "hard rock" site.



Landslides and Liquefaction

Buildings aren't the only thing to fail under the stresses of seismic waves. Often unstable regions of hillsides or mountains fail. In addition to the obvious hazard posed by large landslides, even non lethal slides can cause problems when they block highways they can be inconvenient or cause problems for emergency and rescue operations.

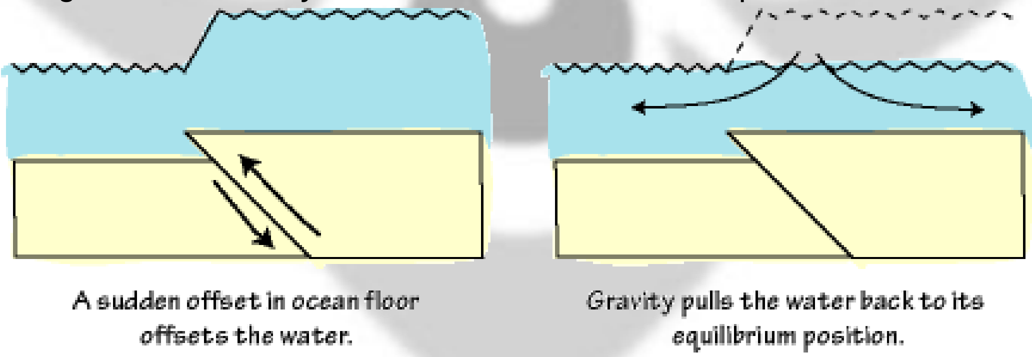
Occasionally, large landslides can be triggered by earthquakes. In 1970 an earthquake off the coast of Peru produced a landslide than began 80 miles away from the earthquake. The slide was large (witnesses estimated it's height at about 30 meters or 100 feet), traveled at more than one-hundred miles per hour and plowed through part of one village and annihilated another, killing more than 18,000 people.In some cases, when the surface is underlain by a saturated, sand rich layer of soil, prolonged shaking can cause the expulsion of fluid from the sand layer resulting in large "sand blows" that erupt through the overlying strataIn the 1811-12 earthquakes the sand blows were enormous and covered large regions of the Missouri bootheel. Liquefaction can cause other problems as the soil loses it ability to resist shear and flows much like quick sand. Anything relying on the substrata for support can shift, tilt, rupture, or collapse.

Tsunamis

A sometimes dramatic by product of certain types of earthquakes are tsunamis. Tsunami is a Japanese term that means "harbor wave". Tsunamis are frequently confused with tidal waves, but they have nothing to do with the tides, they are the result of a sudden vertical offset in the ocean floor caused by earthquakes, submarine landslides, and volcanic deformation. In 1883 the volcanic eruption of Krakatoa resulted in the collapse of a caldera that initiated a tsunami which killed 36,000 people on nearby islands. On June 25, 1896 an earthquake off the Japanese coast generated a tsunami that hit the shore with wave heights ranging from 10 to 100 feet. As the fishing fleets returned to shore following an overnight trip they found their villages destroyed and 22,000 people dead. In the last century more than 50,000 people have died as a result of tsunamis.

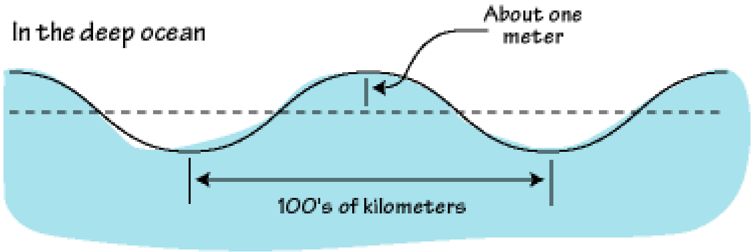
Tsunami Initiation

A sudden offset changes the elevation of the ocean and initiates a water wave that travels outward from the region of sea-floor disruption. Tsunamis can travel all the way across the ocean and large earthquakes in Alaska and Chile have generated waves that caused damage and deaths in regions as far away as California, Hawaii and Japan.



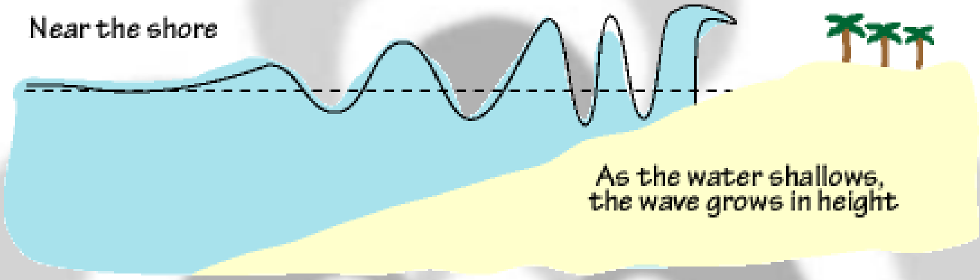
Tsunamis are initiated by a sudden displacement of the ocean, commonly caused by vertical deformation of the ocean floor during earthquakes. Other causes such as deformation by landslides and volcanic processes also generate tsunamis.

The speed of this wave depends on the ocean depth and is typically about as fast as a commercial passenger jet (about 0.2 km/s or 712 km/hr). This is relatively slow compared to seismic waves, so we are often alerted to the dangers of the tsunami by the shaking before the wave arrives. The trouble is that the time to react is not very long in regions close to the earthquake that caused the tsunami.



In deep water tsunamis are not large and pose no danger. They are very broad with horizontal wavelengths of hundreds of kilometers and surface heights much much smaller, about one meter.

Tsunamis pose no threat in the deep ocean because they are only a meter or so high in deep water. But as the wave approaches the shore and the water shallows, all the energy that was distributed throughout the ocean depth becomes concentrated in the shallow water and the wave height increases.



When a tsunami approaches the shore, the water depth decreases, the front of the wave slows down, the wave grows dramatically, and surges on land.

Typical heights for large tsunamis are on the order of 10s of meters and a few have approached 90 meters (about 300 feet). These waves are typically more devastating to the coastal region than the shaking of the earthquake that caused the tsunami. Even the more common tsunamis of about 10-20 meters can "wipe clean" coastal communities.

Deadly tsunamis occur about every one to two years and they have at times killed thousands of people. In 1992-93 three large tsunamis occurred: one in Japan, Indonesia, and Nicaragua. All struck at night and devastated the local communities.

WHAT CAUSES EARTHQUAKES?
The earth has four major layers: the *inner core, outer core, mantle* and *crust*. The crust and the top of the mantle make up a thin skin on the surface of our planet. This is called the lithosphere. Lithosphere is madeup of what are known as plates with a variable thickness of 100-150 kms. These plates covering the surface of the earth are in movement with respect to each other such as slowly moving around, sliding past one another and bumping into each other. These plates are called as tectonic plates and the edges of the plates are called the *plate boundaries*. The plate boundaries are made up of many faults, and most of the earthquakes around the world occur on these faults. Since the edges of the plates are rough, they get stuck while the rest of the plate keeps moving. Finally, when the plate has moved far enough, the edges unstick on one of the faults and there is an earthquake.
While the edges of faults are stuck together, and the rest of the block is moving, the energy that would normally cause the blocks to slide past one another is being stored up. When the force of the moving blocks finally overcomes the *friction* of the jagged edges of the fault and it unsticks, all that stored up energy is released. The energy radiates outward from the fault in all

directions in the form of *seismic waves* like ripples on a pond. The seismic waves shake the earth as they move through it, and when the waves reach the earth's surface, they shake the ground and anything on it, like our houses and us!

The short answer is that earthquakes are caused by faulting, a sudden lateral or vertical movement of rock along a rupture (break) surface.

Here's the longer answer: The surface of the Earth is in continuous slow motion. This is plate tectonics--the motion of immense rigid plates at the surface of the Earth in response to flow of rock within the Earth. The plates cover the entire surface of the globe. Since they are all moving they rub against each other in some places (like the San Andreas Fault in California), sink beneath each other in others (like the Peru-Chile Trench along the western border of South America), or spread apart from each other (like the Mid-Atlantic Ridge). At such places the motion isn't smooth--the plates are stuck together at the edges but the rest of each plate is continuing to move, so the rocks along the edges are distorted (what we call "strain"). As the motion continues, the strain builds up to the point where the rock cannot withstand any more bending. With a lurch, the rock breaks and the two sides move. An earthquake is the shaking that radiates out from the breaking rock.

People have known about earthquakes for thousands of years, of course, but they didn't know what caused them. In particular, people believed that the breaks in the Earth's surface--faults--which appear after earthquakes, were caused *by* the earthquakes rather than the cause *of* them. It was Bunjiro Koto, a geologist in Japan studying a 60-mile long fault whose two sides shifted about 15 feet in the great Japanese earthquake of 1871, who first suggested that earthquakes were caused by faults. Henry Reid, studying the great San Francisco earthquake of 1906, took the idea further. He said that an earthquake is the huge amount of energy released when accumulated strain causes a fault to rupture. He explained that rock twisted further and further out of shape by continuing forces over the centuries eventually yields in a wrenching snap as the two sides of the fault slip to a new position to relieve the strain. This is the idea of "elastic rebound" which is now central to all studies of fault rupture.

CAN SCIENTISTS PREDICT EARTHQUAKES?

No, and it is unlikely they will ever be able to predict them. Scientists have tried many different ways of predicting earthquakes, but none have been successful. On any particular fault, scientists know there will be another earthquake sometime in the future, but they have no way of telling when it will happen. But scientists can tell the areas which are prone to earthquake with the help of seismic zonation maps.

However with help of abnormal behavior of the animals prior to an earthquake such as rats living their hideouts, fishes jumping above the surface of water, rabbits hoping aimlessly about, by measuring the large fluctuations of water table that occur before an earth quake, it is possible to predict the earth quake, but not much earlier to disastrous.

CONCLUSIONS

Earth quakes are natural hazards that poses threat to man kind. Understanding of the earth quakes and mitigation is a challenge to man kind. By studying the seismic prone regions one can prevent the damages to the man kind. Seismic zonation maps helps us to create awareness among the general public about the effects of the earth quake. Prediction of earth quake is a difficult task at present, however, with the advancement of the seismic science in future hope it may become possible.