Chapter 3: Earth's Shakes and Quakes

THE BIG QUESTION: What happens beneath Earth's surface to cause earthquakes?

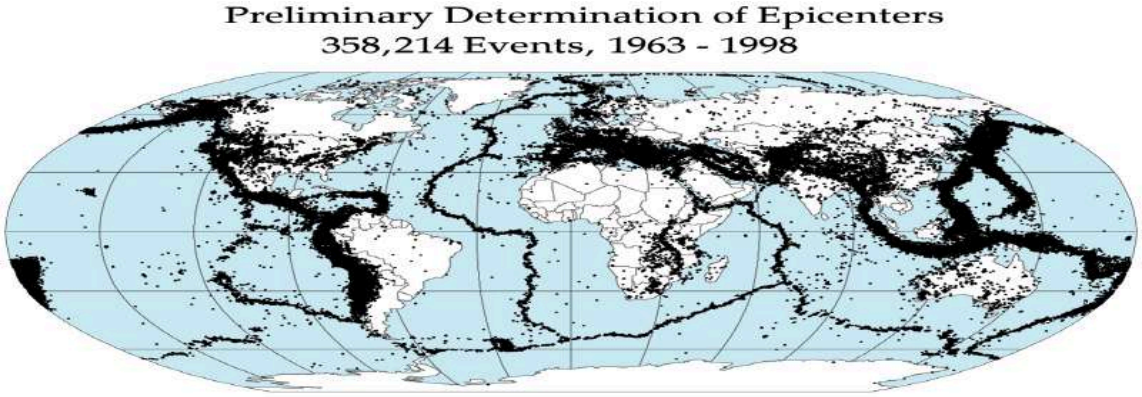
Francesco Petrarch was a writer in the Middle Ages. Can you guess what he was writing about?

The ground shook beneath me. The books bumped and fell, making a loud noise. I felt scared, so I quickly left the room. Outside, I saw the servants and many other people running around nervously. Everyone's face looked pale.

If you said an earthquake, you're right! In northern Italy, there was a big earthquake on a winter day in 1348 CE. Lots of people were very scared and lost their lives.

Earthquakes are strong natural events that happen without any warning. All of a sudden, the ground starts to shake. Furniture falls over, things drop from shelves, and buildings may fall down. A long time ago, in 1348 CE, people didn't know what caused earthquakes. Now we know that earthquakes happen because of powerful natural forces deep inside the Earth.

In the 1960s, scientists developed a theory about how the Earth's surface changes. They found out that the Earth's surface moves very slowly. Some parts move apart, some parts crash into each other, and some parts slide past each other. A lot of things happen where these parts meet, including earthquakes. One way to find these meeting parts is to see where the earthquakes are happening!



Forces and Faults

Put your arms in front of you so they are straight. Put your hands together with your palms and fingers flat. Push your hands together and try to increase the pressure. Make your right hand quickly slide forward. This is like what happens at a fault.

A fault is a crack in Earth's surface. Most faults happen where big rocks get stuck and then suddenly break and move. This happens because the pressure from the hot material underneath Earth's surface makes the rocks break and release a lot of energy.

The Pacific Plate is a really big rock under the Pacific Ocean. It takes a lot of energy to move it and the water on top. If the energy is released suddenly at a fault, it causes a big burst of energy that travels in all directions as seismic waves. These waves make the ground shake a lot. This shaking is what we call an earthquake.

San Andreas Fault

In the United States, there is a famous fault called the San Andreas Fault in California. It's where two big rocks are next to each other but move slowly. Sometimes they stay stuck for a long time, and then suddenly they move and make an earthquake. One time in 1906, there was a huge earthquake in San Francisco. The big slip that caused it made the rocks on each side of the fault move more than 20 feet in just a few seconds!

Shake, Heave, Sway, and Lurch

Earthquakes start when big blocks of rock move along cracks in the ground, called faults. The spot in the Earth’s skin where this happens is called an earthquake's focus. Imagine it as the heart of the earthquake, where the shaking waves come from. The focus might be very deep in the Earth's crust or not too far down.

The middle point where an earthquake starts on the Earth's surface is called the epicenter. Some earthquake movements make deep waves inside the Earth. But the first shaking that people feel during an earthquake happens at the epicenter because of the surface waves. These surface waves cause the ground to shake, move, and sway during an earthquake. They are what creates most of the damage during an earthquake.

In Chapter 2, you read about something called seismographs. Scientists use seismographs to record when the ground shakes because of something called seismic waves. The time it takes for these waves to reach a seismograph is important. It helps scientists figure out where an earthquake happened. The longer it takes for the waves to reach a seismograph, the farther away the earthquake is from it.

Seismographs: Now and Then

A modern seismograph, also known as a seismometer, keeps track of the shaking of the Earth's surface. It makes a record called a seismogram. A seismogram looks like up-and-down lines and shows the seismic waves. Scientists use seismograms to figure out where an earthquake starts.

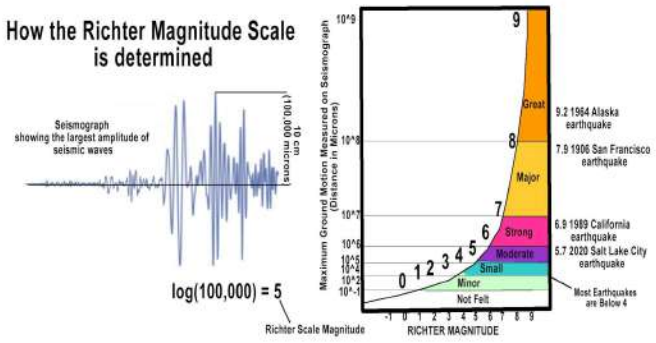
Zhang Heng was a smart person from China. He made something special called a seismograph long ago, around the year 132. This seismograph didn't look like what we have now. It looked like a big vase. On the vase, there were eight dragons all around it. Each dragon was looking down and holding a ball in its mouth. Below the dragons, there were frogs with open mouths. When there was an earthquake, the balls would fall into the frogs' mouths. By seeing which balls fell, people could figure out how far away the earthquake was and which way it came from.

Measuring an Earthquake’s Strength

Scientists use special tools to measure how strong an earthquake is. When there is a small earthquake, the ground shakes just a little bit. This is shown on a special graph with small wiggles. But when there is a big earthquake, the ground shakes much harder. This is shown on the graph with big zigzags.

An earthquake is a big shaking in the ground. Scientists measure how big the shaking is using the Richter scale. It gives a number to the earthquake based on how much shaking there is. The higher the number, the stronger the earthquake. If the number is bigger by 1, the shaking is 10 times more. For example, a 5.0 earthquake shakes 10 times more than a 4.0 earthquake, and a 6.0 earthquake shakes 10 times more than a 5.0 earthquake.

The Modified Mercalli Intensity Scale uses numbers to measure earthquake strength. The numbers are based on survivors’ descriptions and the amount of earthquake damage. The higher the number, the stronger the earthquake. Earthquakes can happen very quickly. Although most earthquakes last just a few seconds, large earthquakes are often followed by smaller and weaker aftershocks, which happen as rocks settle back into place.



Earthquakes at Sea

Most earthquakes happen where tectonic plates meet. Some of these plate boundaries are in the ocean, so a lot of earthquakes happen under the sea. This is very true in the Pacific Ocean. The Pacific Ocean has many deep areas where one part of the Earth's outer shell is moving beneath another part. Earthquakes happen a lot in the land near these deep ocean areas. Earthquakes that occur in the crust forming the ocean bottom can cause the seafloor to shift. This shift can cause seawater, from the ocean bottom to its surface, to suddenly start to move. The result is a gigantic wave called a tsunami.

Tsunamis move very fast. They can go as fast as 500 miles per hour. If you are in the middle of the ocean, you might not even notice the big wave passing by. But when the tsunami gets closer to the land, all the water gathers up and becomes a very tall wall of water, almost like a three- or four-story building. The tsunami hits the shore very hard and goes far onto the land. Then it goes back out to the sea. Tsunamis can cause a lot of damage.