Module 2, Investigation 1: Earthquake Hazards

Introduction

Welcome!

You have learned how scientists describe and study volcanoes. Now you will see how they describe and study earthquakes. The first step is to learn how earthquakes are described. Then you can visit some of the world's most infamous earthquakes and see how they affected people. As a scientist, your job is to learn to predict how much damage an earthquake might cause. This information will help communities prepare for and respond to earthquakes.

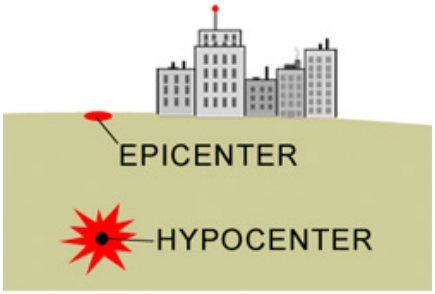
Check your Google Earth settings!

1. Turn off all Layers except **Borders** and **Labels**.
2. Select Tools > Options > 3D View > Units of Measurement > select **Meters, Kilometers**.
3. Select Tools, > Options > 3D View > Terrain Quality > check "Show terrain" > enter **2** for **Elevation Exaggeration**.
4. Select Tools > Options > 3D View > Show Lat/Long > check **Decimal Degrees**.
5. Select Tools > Options > Touring > check "**Show balloon when waiting at features**".

Folder 1: Earthquake Anatomy

Epicenter and Hypocenter

Earthquakes are caused by a wave of energy below ground. The spot where the wave starts is called the "hypocenter". The spot on Earth's surface directly above the hypocenter is called the "epicenter"

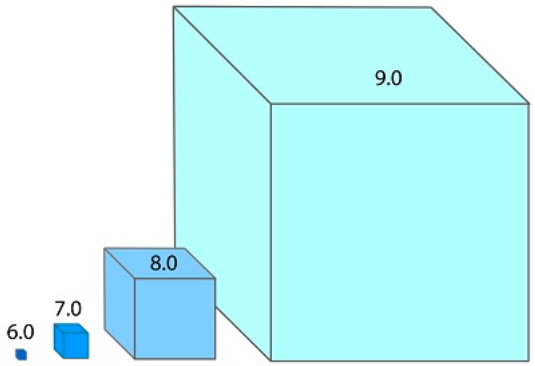


Anatomy of an earthquake.

Folder 1: Earthquake Size

Magnitude and Intensity

Earthquakes have both "magnitude" and "intensity". Magnitude (M) is the amount of energy released at the earthquake hypocenter. An earthquake has only one magnitude. Scientists use seismographs to determine magnitude. M values are assigned using the Moment Magnitude Scale. On this scale, each higher number represents an order of magnitude increase in energy. That means an M 9.0 earthquake is much more powerful than an M 8.0 earthquake.



Relative amount of energy released by earthquakes of higher magnitude.

Folder 2: Shaanxi Earthquake

Landslides

In the 16th century, China's economy was booming. On the morning of January 23rd, 1556, east-central China experienced the deadliest earthquake in recorded history. Cracks up to 20 m (66 ft) deep opened up on the land surface. An estimated 830,000 people were killed. The epicenter was in the Weihe River Valley in the province of Shaanxi. The magnitude is estimated to have been about M 8.0.

Ancient texts record structural damage to homes and temples. These buildings were typically made out of stone and brick. Timber frame construction was also becoming common. In the cities of Huaxian, Weinan, and Huayin, nearly every building was leveled, killing tens of thousands of people. The earthquake also triggered massive landslides (see video). These caused even more deaths.

[Landslide video]

Folder 3: San Francisco Earthquake

Soils and Intensity

On April 18, 1906, an M 7.8 earthquake hit the coast of California. The quake left a large crack in the ground from San Juan Bautista to Cape Mendocino. In many places the ground

shifted sideways several meters. (See the fence in the photo below.) Scientists did not understand these shifts or how the gash in the ground surface could be so long. You will learn more about these fractures, which are called "fault ruptures", in the next investigation.

Fence displaced by the 1906 earthquake.
Photo: G.K. Gilbert / USGS.

The earthquake epicenter was near the city of San Francisco. The event lasted less than a minute. It included several strong jolts with violent shaking in between. People as far away as southern Oregon, Los Angeles, and central Nevada felt vibrations.

In San Francisco many buildings collapsed. Fires caused by broken gas lines destroyed even more structures. In the end approximately 3,000 people died and between 225,000 and 300,000 were left homeless.

Click here to view the GigaPan image and explore all the close-up views.

Shortly after the earthquake, scientists determined that the earthquake intensity had varied from place to place. Buildings sitting on soft ground, like sand and mud deposits, shook a lot. Building sitting on bedrock shook the least. Areas along the shoreline that had been artificially filled in by developers shook most of all.

Folder 4: East Indian Ocean Earthquake

Tsunami

On December 26th, 2004, an M 9.1 earthquake occurred in the East Indian Ocean. The earthquake was felt through the entire Bay of Bengal, and eastward to Thailand. The earthquake was accompanied by an enormous tsunami (see video). The tsunami killed more people than any other in recorded history. Estimates range from 180,000 to 230,000 deaths and from 1.0 to 1.7 million people displaced in South Asia and East Africa.

The waves spread out in all directions. They went west across the Indian Ocean. They went south into the Southern Ocean. They went east to Australia and New Zealand. Unusually large waves were even recorded along the coasts of North and South America.

[Tsunami video]

Summary

Let's Reflect

Now you have visited some of the most infamous earthquakes on Earth. You have learned how earthquakes are described. You have seen how they can affect people and the landscape. You also know what factors affect earthquake intensity. Now it is time to summarize this information in your field notebook. You will want to refer to these notes later.

Folder 5: Going Further (Tsunami Preparedness)

Maputo, Mozambique

You are living on the southeastern coast of Africa in the city of Maputo, Mozambique. You have been notified that you have ten hours before a tsunami hits. Where will you go and what will you take with you? Why?

View the tsunami preparedness video (below) to help you with your plans.

[Tsunami preparedness video]

Folder 6: Going Further (Mapping Damage)

Port-au-Prince, Haiti

On January 12, 2010, an M 7.0 earthquake struck the island nation of Haiti. Many buildings collapsed in the capital city of Port-au-Prince. An estimated 222,000 people died. Over a million people were left homeless.

The shaking was recorded by a network of seismographs. Scientists use these data to make maps of earthquake intensity. These special maps are called “ShakeMaps”. They show estimated intensity in between seismograph stations. They are used by local authorities to help plan emergency response. They are also used for scientific research.