Locating Earthquakes

Seismic waves generated during an earthquake include body waves that radiate away from the ______________ (aka _________________) and surface waves that radiate away from the ____________ where the body waves first reach the surface. These waves are eventually felt at various distances from the earthquake. The further away from the earthquake you are, the longer it takes for the waves to reach you.

It is possible to figure out exactly how far away you are from an earthquake based on the arriving seismic waves.

We can do this by looking at the _________________ record of the earthquake.

What is the first recorded wave arrival? _________________

What is the second recorded wave arrival? _________________

What are the last wave arrivals to get recorded? _________________

What do we call the difference in the arrival time between the first two wave types? _________________

As the distance away from the earthquake increases, what happens to this time interval between the P and S-waves?

Is it LONGER or SHORTER?

So if you measure the P-S time interval, you know how far away from the earthquake you are. But this method doesn’t tell which direction the waves came from (i.e. the direction to the earthquake epicenter). The direction to the earthquake can only be determined using a number of seismograph station records of the quake.

How many seismograph stations are needed to locate an epicenter? _________

For each station, the distance from the earthquake is calculated based on the P-S time interval. Then, a pencil compass is used to draw a circle around each seismograph location on a map, with a radius equal to the distance to the earthquake.

What is it about the three circles around the three different seismograph stations that indicate the location of the epicenter?

Measuring Earthquakes

Magnitude

The magnitude of an earthquake refers to: _________________

What is the most well known magnitude scale? _________________
What two characteristics of the seismic waves are used to calculate this magnitude?

1. ___________________________
2. ___________________________

The scale starts at 0 and increases logarithmically. In other words, an increase of 1 unit on the magnitude scale corresponds to a _____ times larger wave amplitude.

BUT, an increase of 1 Richter magnitude corresponds to ________ times more energy release during the earthquake.

So it would take 30 M6 earthquakes to release as much energy as a single M7 earthquake.

Most earthquakes have a magnitude that is less than ________, so we don't feel them. Only seismographs can feel them.

The problem with the Richter magnitude scale is that it cannot accurately measure the really big earthquakes because the seismograph readings go off the scale.

What magnitude scale do we use for the really big earthquakes? ________________________________

It is also logarithmic, just like the Richter scale, but it is measured differently. It considers characteristics of the actual physical motion along the fault.

What two aspects of the fault motion are considered for the moment magnitude scale?

1. ___________________________
2. ___________________________

The largest earthquake ever recorded was a subduction zone earthquake off the coast of ____________ in South America in 1960 had a moment magnitude of ________.

The 1964 Alaska earthquake had a magnitude of _________. It released about _____ times more energy than the 1994 M6.7 Northridge earthquake in Los Angeles.

Even though very large earthquakes don't happen very often, they can release as much energy as many thousands of smaller earthquakes.

**Earthquake Intensity**

The trouble with using magnitude to determine the size of an earthquake is that it doesn't tell us much about how potentially damaging an earthquake can be.

For example, magnitude doesn't change no matter how far away from the earthquake you are. But the amount of ground shaking and damage caused by an earthquake always _______________ as you go further and further away from the epicenter.

The severity of earthquake damage also varies with __________________________.
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e.g., the 1994 Northridge earthquake was a M6.7 and did a huge amount of damage. The 2001 Nisqually earthquake near Seattle was bigger- a M6.8 - yet it didn't do nearly as much damage.

What is the reason for this? ____________________________________________

To account for these discrepancies between the magnitude of an earthquake and the amount of damage that is done, we often use a different scale for measuring earthquakes, called the __________________ of the earthquake.

This scale is a direct measure of the amount of ________________ caused locally by the earthquake.

What intensity scale is commonly used? _________________________________ (varies from I to XII)

The largest intensities occur near the ______________ of the earthquake, but typically decrease away from this point.

What major earthquake in 1812 in the central US caused shaking that was felt as far away as Boston? ______________________________________

**Earthquake Hazards**

Although we are most familiar with earthquake damage resulting from strong ground motions that cause buildings and other structures to collapse, there are a number of potential hazards associated with earthquakes (fill in the following list).

1. ___________________________ (e.g. rolling surface waves)
   
   This phenomenon is greatly controlled by the nature of the underlying rocks and sediments.
   
   Why is this? _______________________________________________________________________
   
   Example: ________________________________ (Oakland, CA, 1989) M6.9

2. ____________________________
   
   Why is this a significant hazard? ____________________________________________________

3. ____________________________
   
   Where do these form? ______________________________________________________________

4. ____________________________ - can be massive, or lots of smaller slides.
   
   Where is this hazard going to be greatest? ____________________________________________
   
   Example: ________________________________ (1970) – caused 25,000 deaths
   
   Example 2: ________________________________ (1959, M7.3) – slide blocked a river.
   
   Example 3: ________________________________ (1964, M9.2) – neighborhood of Turnagain Heights in Anchorage slid into the sea.
5. ____________________ - causes buildings to topple over

   Definition: ________________________________________

6. ____________________ (from broken gas mains)

   Example: ________________________________________

7. ____________________ (sudden shift of the ocean floor causes a giant wave)

   Example: ___________________ was hit after a 1946 Alaska earthquake.

What major M9.0 Pacific Northwest earthquake was known to have occurred only because of the resultant tsunami that hit the coast of Japan? _______________________

The worst natural disaster of the modern age resulted from the M9.1 Sumatra earthquake in Indonesia in 2004 that caused a tsunami that ultimately killed __________________ people.

   **FINAL QUESTIONS:**

   What type of map indicates the distribution of regions at risk from earthquakes?

   _________________________

   What cool class about earthquakes is being offered in the Spring?  ______________