

2/12

Earthquakes

- What causes earthquakes?
 - o Motion along faults
 - o Stress > friction
- How frequent are earthquakes?
 - o Very frequent
 - o 1,000,000 per year (magnitude 2)
- The point of movement
 - o **Focus:** point on fault from where the motion is derived
 - Remember that the entire fault line does not move at once!
 - Many foci are 2-20 km deep in continental crust (shallow)
 - Need brittle rock to move very suddenly
 - o **Epicenter:** point on the surface directly above the focus
 - Helpful in locating town/city
- Movements before and after
 - o **Foreshocks:** before; an attempt by the rocks to release some of the built up stress
 - Sometimes the foreshocks can suppress the entire earthquake, but this is rare
 - o **Aftershocks**
 - The last little bits of energy are being released
 - Rocks in the surrounding regions may have to adjust their positions after the earthquake
- Seismic Waves
 - o 3 different types; all earthquakes generate all 3 types of waves
 - o 1- **P (Primary) Waves**
 - fastest- 6km/s (twice the speed of sound waves through the air)
 - compressional in nature (think of a slinky)
 - can move through both solids and liquids (all layers)
 - o 2- **S (Secondary/Shear) Waves**
 - move slower- 3 km/s (half the speed of P waves)
 - move more like an actual wave (vertical displacement, up and down), not compressional,
 - can only move through solids
 - if wave hits liquid, it just fizzles out
 - the particles in a liquid are spread out and bouncing around, the wave cannot move
 - can move through lithosphere and asthenosphere

- **S-Wave shadow zone:** the area on the other side of the planet that S-Waves do not reach because of the consistency of the ductile outer core
- o **L (Long, Surface) Wave**
 - Stay closer to the surface of the earth
 - Slower
 - More complicated motion
 - Vertical + lateral motion
 - Particles are pushed up and to the side
- Measurement and Detection
 - o **Seismometer** (seismograph=outdated)
 - 3 myths to debunk
 - 1- solo machines
 - o need 3 devices to properly detect.
 - N/S movements
 - E/W movements
 - Vertical movements
 - Without all three, data sets will be inaccurate
 - 2- old fashioned machines
 - o no longer the machine with the suspended needle and scroll of paper
 - o everything is digital now
 - 3- swinging needles
 - o THE NEEDLE NEVER ACTUALLY MOVES
 - o If needle and paper and device moved, nothing would change
 - o The needle is kept still so when the rest of the device+paper moves, it can record the movement
 - Data: ***See diagram on slide 15***
 - Waves arrive in order—P,S,L
 - Why do we need timing of each wave arrival?
 - o Key to finding the focus is that the different waves travel at different speeds.
 - To find approximate location:
 - o take difference between arrival times of P and S waves, calculate how many miles that equals for each seismometer.
 - o Plot these distances as radii around the 3 machines
 - o Wherever the 3 circles intersect is where the epicenter is located
 - o Most data stations use 100+ data sets to get the location down to fractions of an in

- o How big was it? 3 different scales
 - **1- Mercalli Index:**
 - bigger numbers=more powerful
 - 1-12
 - PROS:
 - o easy to spot in a report because it uses roman numerals
 - o measure amount of property damage (fires, house collapse, etc)
 - o helps with insurance/new construction, materials
 - CONS:
 - o not useful for studying an earthquake from a scientific perspective
 - o same magnitude earthquakes that happen in Manhattan/middle of nowhere will have different ratings on the scale
 - depends on how much property there is to damage
 - no property=low rating
 - **2- Richter Scale**
 - 1-10; scale increases by *factor of 10* for each step
 - o energy increases by a *factor of 30*
 - bigger number=bigger earthquake
 - measures the amount of Reynold motion for a given area
 - o how much did the ground move?
 - Not really used by geologists anymore
 - Famous, but fallen out of use
 - CONS:
 - o The amount of motion felt is related to the proximity to the epicenter
 - Correction factor for distance
 - More motion felt closer to epicenter
 - Extra calculation step is annoying to calculate
 - o Once the earthquake is over, there is nothing to go back and re-measure
 - Malfunctions in seismometer=incorrect data
 - No Richter value for earthquakes that occurred before its invention
 - **3- Moment Magnitude**
 - measure how much the rocks moved at the focus
 - many advantages to the Richter scale
 - used by most scientists
 - 1-10, similar to Richter scale
 - smaller earthquakes: moment rating=Richter rating