

Natural Disasters

Lecture 12

Ch 3 – Earthquake Geology and Seismology

Text Source Today:

Chapter 3 (p. 51-59)

3.1: Ch. 3 – Earthquake Geology and Seismology

♦ **Lisbon Earthquake of 1755:** a series of **three major earthquakes** in a little over 2 hours struck Lisbon, Portugal, killing nearly 70,000 and destroying or seriously damaging about 90% of the houses and churches in the city! This great natural disaster occurred at a time in history when Europe was enjoying **“an air of prosperity and tranquility in an ordered world.”** It changed the prevailing philosophies of the era.

♦ **What is an Earthquake?** Stresses build up in near-surface rocks until the stress is so great that the **rocks fracture and shift along a fault**; the **shock waves** sent off as the rock ruptures and moves are what we experience as an “earthquake.”

Niels “Steno” Steensen, 1669, set forth several laws that are fundamental in interpreting geologic history: (Fig. 3.4)

- **Law of original horizontality:** sediments (sands, gravels, muds) are originally deposited or settled out of water in **horizontal layers**.

- **Law of superposition:** in an undeformed sequence of sedimentary rock layers, each successive layer is deposited **on top of a previously formed, and hence, older layer**.

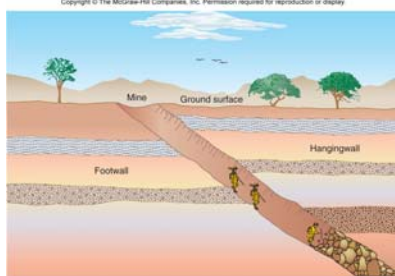
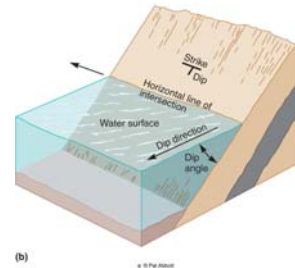
- **Law of original continuity:** sediment layers are **continuous**, ending only by butting up against a topographic high (such as a hill or a cliff), by pinching out due to lack of sediment, or by gradational change from one sediment type to another.



- In order for geologists describe a location in 3-D of a deformed rock layer, a fault surface, or any other planar feature, they measure **dip and strike**. (Fig. 3.7)

♦ **Dip:** the **angle (in degrees)** below **horizontal** that the rock layer is inclined; it is viewed in a 2-D vertical (cross-section) view.

♦ **Strike:** the **compass bearing** of the rock layer where it pierces a **horizontal plane**; it is viewed in a 2-D horizontal (map) view.

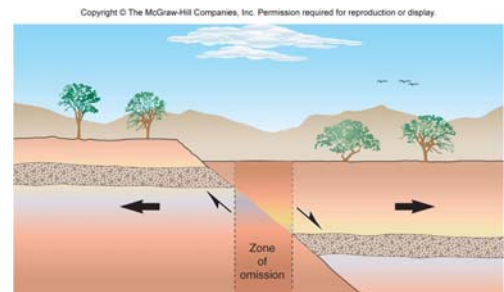


- Early miners, working in excavated **fault zones**, used to call the floor beneath their feet the **footwall** and the rocks above their heads the **hangingwall**. (Fig. 3.8)

♦ **Dip-slip faults:** when the major amounts of their offset in the **dip (vertical) direction** are caused by either a **pulling or a pushing force**. There are two types:

♦ **Normal fault:** occurs when the hangingwall moves **downward** relative to the footwall, due to a **pulling apart**, leading to a separation of rock layers in a **zone of omission**.

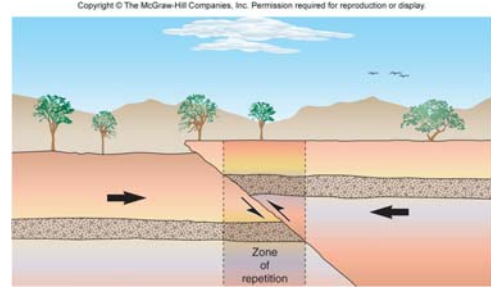
(Fig. 3.9)



- **Normal faults** are typical faults at sea floor spreading centers and in regions of continents where the plates are pulled apart.

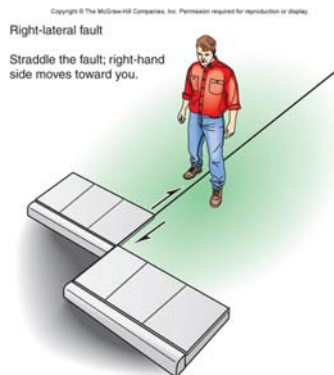
♦ **Reverse fault:** occurs when the hangingwall moves **upward** relative to the footwall, due to **compressional forces**, leading to a stacking of rock layers in a **zone of repetition**.

(Fig. 3.10)



● **Reverse faults** are typical faults at areas of plate convergence where subduction or continental collision occurs.

♦ **Strike-slip faults:** when the major amount of movement along a fault is **horizontal (parallel to the strike direction)**. There are two types (Fig. 3.11):



♦ **Right-lateral fault:** if you straddle a fault and the block on your **right-hand side** has moved relatively **toward you**.

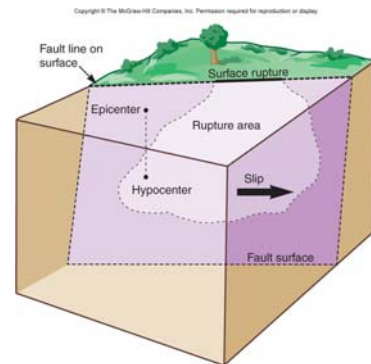
♦ **Left-lateral fault:** if you straddle a fault and the block on your **left-hand side** has moved relatively **toward you**.

● The most famous strike-slip fault is the **San Andreas in California**. It is a **right-lateral fault** stretching more than 1300 km (800 miles).

♦♦ **Hypocenter (focus):** the point on the fault surface where the rupture began.

(Fig. 3.12)

♦♦ **Epicenter:** the point on Earth's surface directly above the hypocenter.



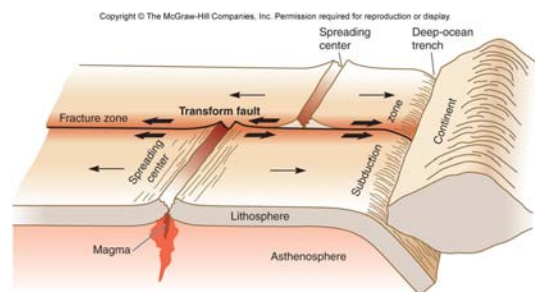
- A fault surface is **not a smooth plane**, but a **complex zone of breakage**, where rough and interlocking rocks are held together **over an irregular surface** that extends many miles below the ground.

- ◆ Thus, an “earthquake” will usually result in not one fault movement, but several. The biggest one in a series is called the **mainshock**. The preceding smaller ones are called **foreshocks** and the smaller ones after it, **aftershocks**.

- **Strike-slip faults** do not create perfectly straight lines, but instead the rupturing fault tears apart the rocks along its path in numerous subparallel breaks that **start and stop**, and **bend left and right**, which can lead to **compression (hills or mountains)** or a **pulling apart (a hole or a basin)** at the bend, depending on the type of strike-slip fault.

- ◆ **Transform faults:** a special type of **horizontal-movement** fault, first recognized in 1965. As rigid slabs of oceanic rock are being wrapped around a curved surface (i.e., the nearly spherical Earth), they **must fracture**. (Fig. 3.15)

- In between the separated oceanic spreading centers, the plates are moving in **opposite directions**, but on either side, they are moving in the **same direction** and are called **fracture zones**.



- **Transform faults** must link spreading centers or connect spreading centers with subduction zones.