

Natural Disasters

Lecture 15

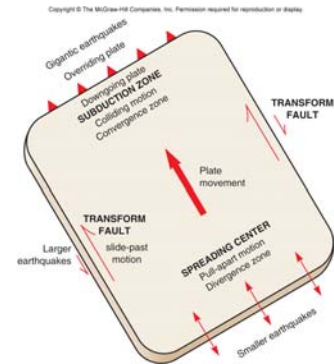
Ch 4 – Plate Tectonics and Earthquakes

Text Source Today:

Chapter 4

4.1: Ch. 4 – Plate Tectonics and Earthquakes

● **Faults:** ruptures in the Earth, where tectonic plates **move away from, past, and into** other rigid plates. (Fig. 4.1)



♦ The **greatest earthquakes in the world** occur where plates **collide** with each other (i.e., **at the edges** of the tectonic plates).

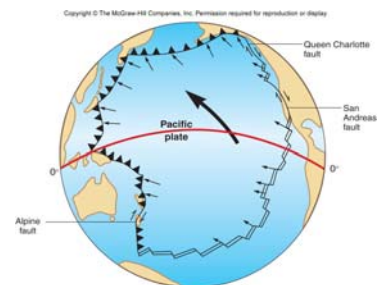
♦ **Divergent, or pull apart**, motion at spreading centers causes rocks to fail in **tension**, mainly due to the **high temperatures**. This usually leads to **smaller earthquakes** that do not pose an especially great threat to humans.

♦ **Transform, or slide-past, horizontal** motion at transform faults causes the rigid plates to **fracture**. This leads to **large earthquakes**, as the irregular plate boundaries retard movement because of the irregularities along the faults. It takes a lot of **stored energy** to overcome the rough surfaces, non-slippery rocks and bends in the faults.

♦ **Convergent, or come together**, motion at subduction zones and in continent-continent collisions store immense amounts of energy that are released in Earth's **greatest tectonic earthquakes**.

(Fig. 4.2)

● **Pacific Plate:** (a) **spreading centers** along east and south edges; (b) **transform faults** in northeast edge and extreme southwest; (c) **rest of plate subducts**.



● Spreading Centers and Earthquakes (EQs):

◆ The **high heat-weakened rocks** in spreading centers do not build up and store the huge stresses necessary to create great earthquakes (EQs). These EQs are **exclusively shallow**.

◆ EQs are **not as common in spreading centers** as in the vicinity of transform faults and subduction/collision zones.

● **Iceland** exists on a **hot spot-fed volcanic island** portion of the mature mid-Atlantic ridge (180 million years) spreading center.

(Fig. 4.3)



● The **north-south** oriented spreading centers running through Iceland have been known to cause **moderate-sized EQ swarms** that are too small to destroy buildings or kill people. However, the **east-west** oriented transform faults between spreading center segments can generate **large EQs**.



◆ **Red Sea and Gulf of Aden** exists on a young spreading center (25 million years) that is at a **triple junction** where three plates (African, Arabian, Somali) touch, at the **Afar Triangle**. (Fig. 4.5)

● The **East African Rift Valley** (probable homeland of the first human beings) has not yet been pulled far enough apart to fill with sea water, as has the **Red Sea**.

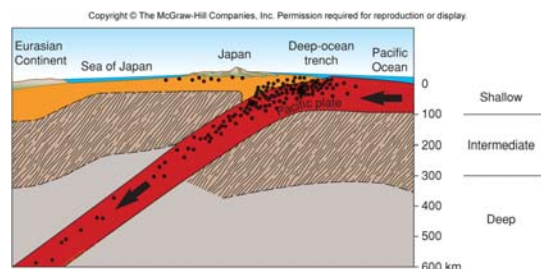
♦ **Convergent Zones and Earthquakes (EQs): the greatest EQs in the world occur where plates collide:**
 (1) ocean-ocean; (2) ocean-continent; (3) continent-continent.

♦ If oceanic plates are involved, **subduction will occur**, with the **younger, warmer, less-dense** (oceanic or continental) plate overriding the **older, colder, denser** oceanic plate. The denser plate will bend downward and be pulled back into the mantle, where it will be **melted and reassimilated into the mantle**.

♦ In a continent-continent collision, **crumpling (mountain building)** will occur. The low-density, high-buoyancy continental rocks cannot **subduct** and will **“float” about** on the asthenosphere in perpetuity.

♦ **Subduction Zones: are the sites of great earthquakes** (Indonesia 2004, 2005; Haiti **2010**; Tokyo, Japan 1923, **2011**).

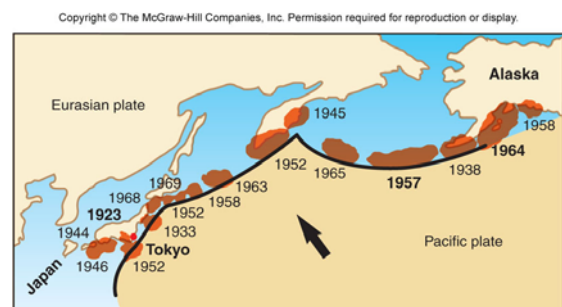
♦ **Shallow EQs** occur in the upper portion of the down-going plate, at the bend and in the overriding plate



♦ **Deep EQs (100 km and below)** occur exclusively in the heart of the subducting slab.

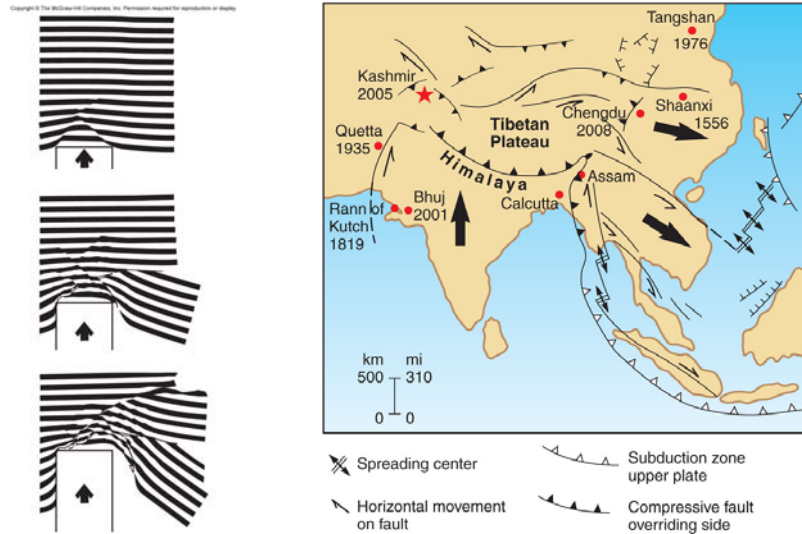
(Fig. 4.9)

♦ **Seismic-gap method** of forecasting EQs: if segments of one fault have moved recently, then it seems reasonable to expect that **the unmoved portions will move next and fill the gaps**.



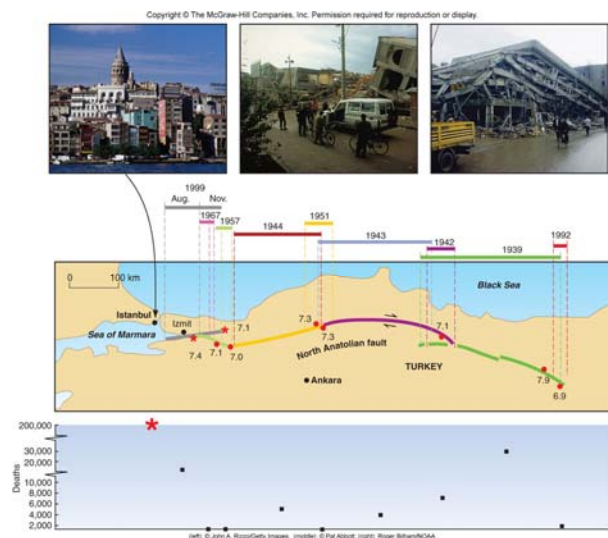
♦ **Continent-Continent Collisions:** the grandest example in the modern world is the **ongoing ramming of Asia by India**, which has created the **Himalayas and the Tibetan Plateau**, as well as keeping a large area subject to **great EQs** (China, Pakistan, India, **2008**, 2005, 2001; Shaanxi Province, China 1556; Tangshan, China, 1976).

Figs. 4.19-20

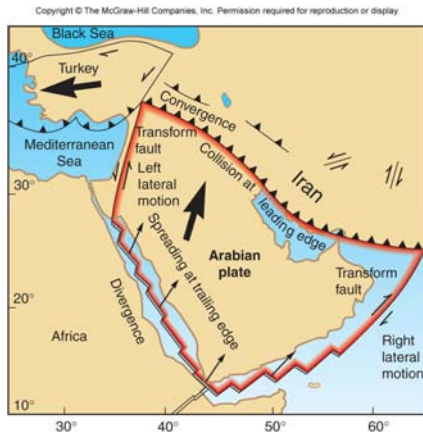


♦ **Transform Faults and Earthquakes (EQs):** the **sides** of some tectonic plates have **horizontal movements that create major EQs** (Turkey, 1999).

♦ The **North Anatolian fault** is caused by the Arabian plate and is forced to move westward and rotate CCW in **escape tectonics**, where the EQs show a **marked progression in time along a distinct path**. What city is next? (Fig. 4.26)



♦ **The Arabian Plate:** offers good insight to different EQ types (Fig. 4.21):



- **Continent-continent collision EQs** as Arabian plate is being driven under the Eurasian plate (Iran, 1962-2007)
- **Spreading center EQs** in the Red Sea and Gulf of Aden

- **Transform Fault EQs** along the sides of the Arabian plate; one side is beneath the Indian Ocean, but the other side runs through the **Holy Land** as the **Dead Sea Fault Zone**. (Fig. 4.22)

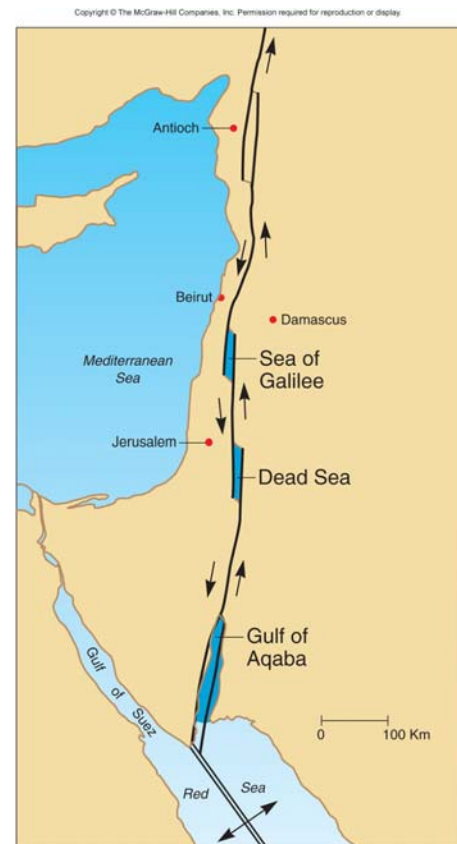
- Has created the **Gulf of Aqaba**, the **Dead Sea** and **Sea of Galilee**

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TABLE 4.4
Some Earthquakes in the Holy Land

Year	Magnitude	Year	Magnitude
1927	6.5	1068	6.6
1834	6.6	1033	7.0
1759	6.5	749	6.7
1546	6.7	658	6.2
1293	6.4	363	7.0
1202	7.2	31 BCE	6.3
		759 BCE	7.3

Source: "When the Walls Came Tumbling Down" (1991). [Video] Amos Nur, Stanford University.



- ♦ **Earthquake Weather Myth:** there is no connection between "weather" (which is solar energy driven) and EQs.

- ♦♦ **Earthquake Fact:** **Earthquakes don't kill, buildings do!**