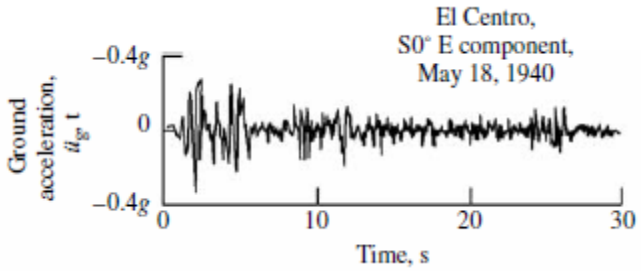
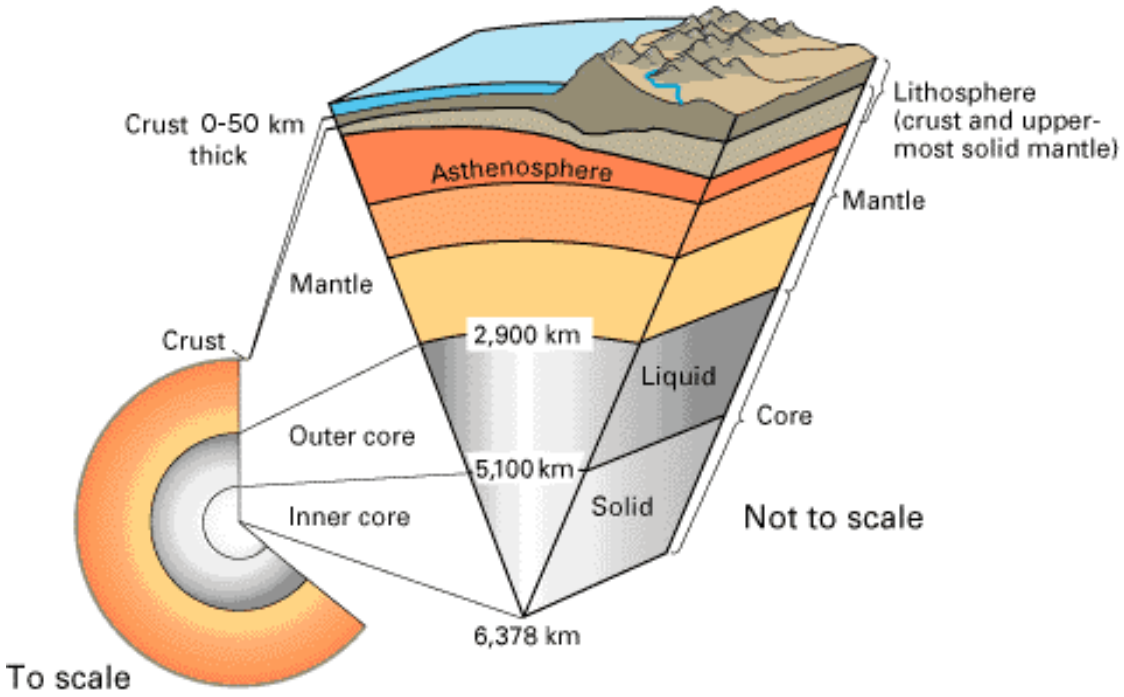
- Earthquake is a sudden shaking or vibration of the earth‘s surface that follows a release of energy in the earth‘s crust



- Thousands of earthquakes occur every year, most earthquakes cannot be felt without sensitive instruments

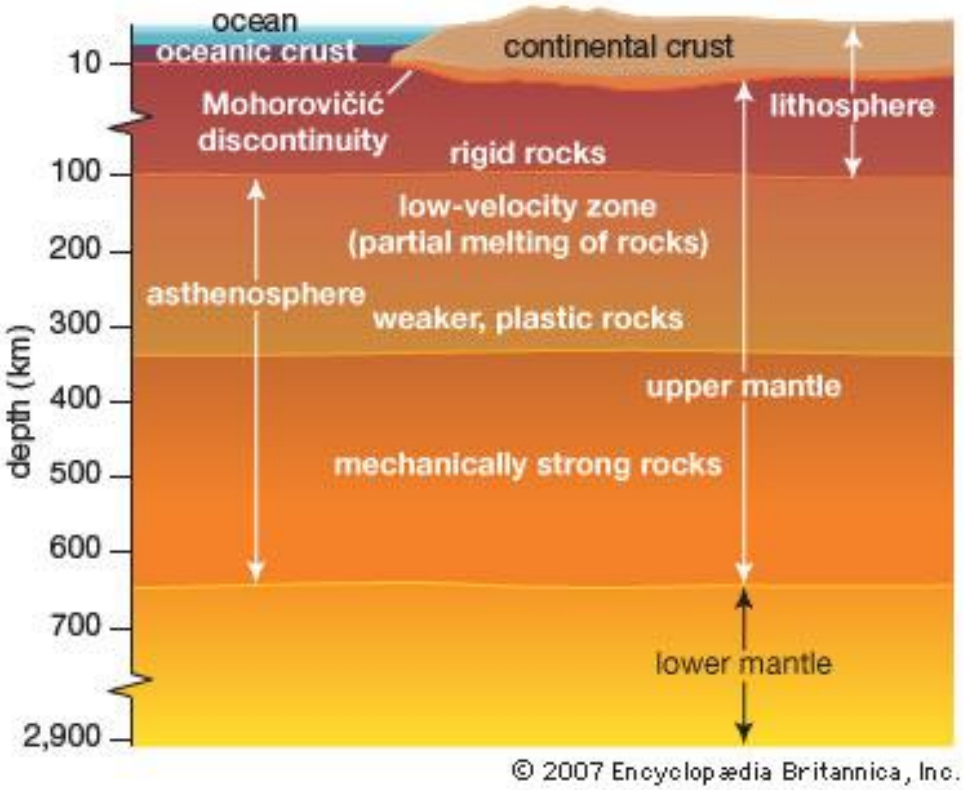
- Causes of earthquakes:
  - Tectonic earthquakes, realtive movements of earth crust
  - Explosions – nuclear or chemical
  - Volcanic earthquakes

Earth‘s interior structure



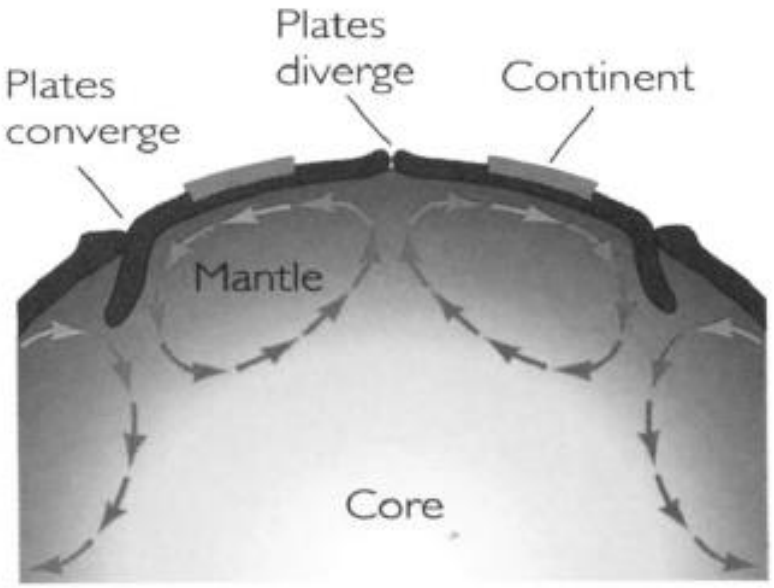
- Earth has three concentric layers; core, mantle and Crust
- There is variation in densities between the different layers
- There are two outermost boundaries of the earth in terms of material strength; **lithosphere** and **asthenosphere**

Cross-section of outermost part of earth



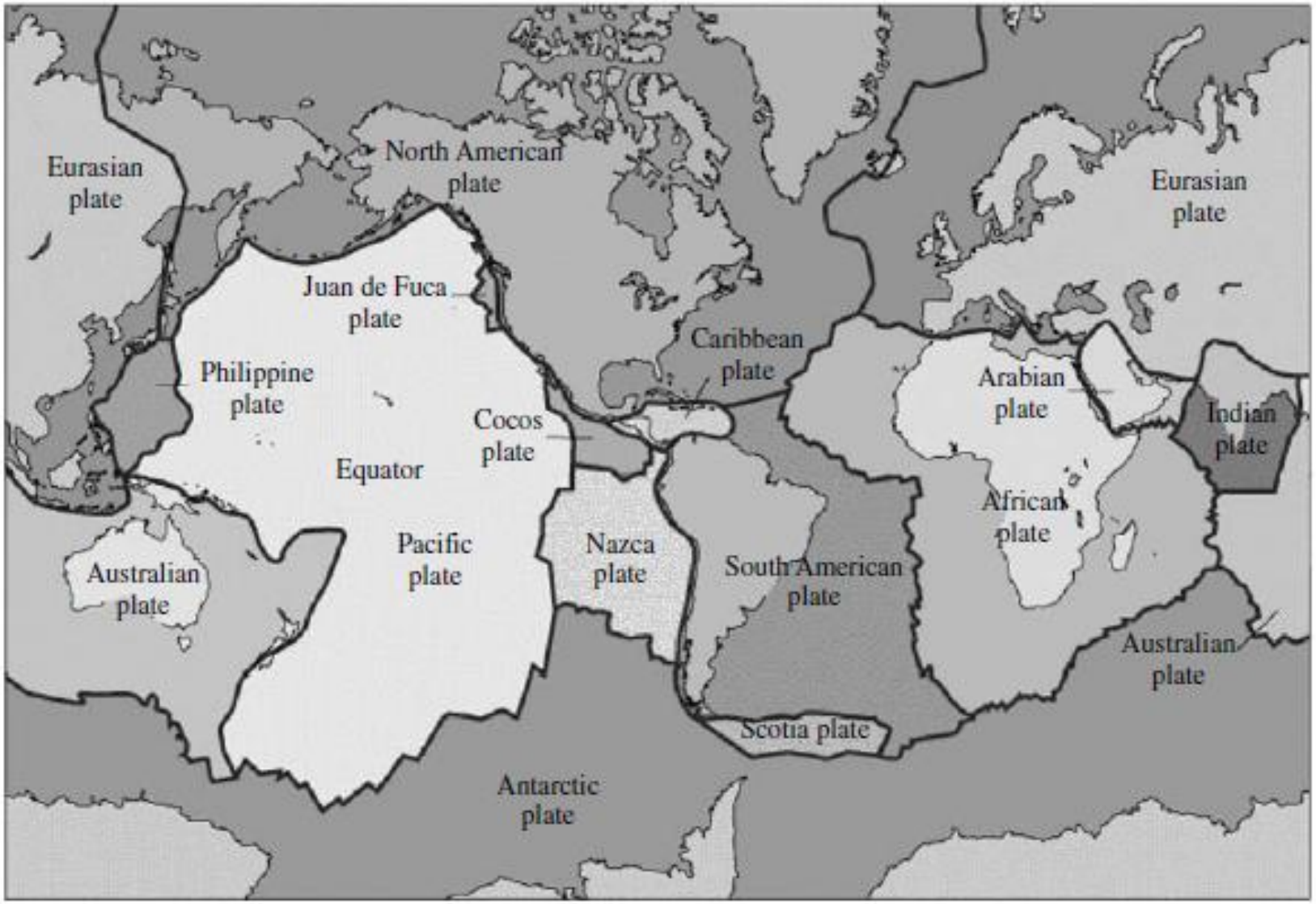
- The lithosphere is rigid and relatively strong, it is formed of crust and outermost part of matle
- The asthenosphere lies below lithosphere , which forms the weak part of mantle
- **Lithosphere floats over asthenosphere**

Earth is in constant motion!

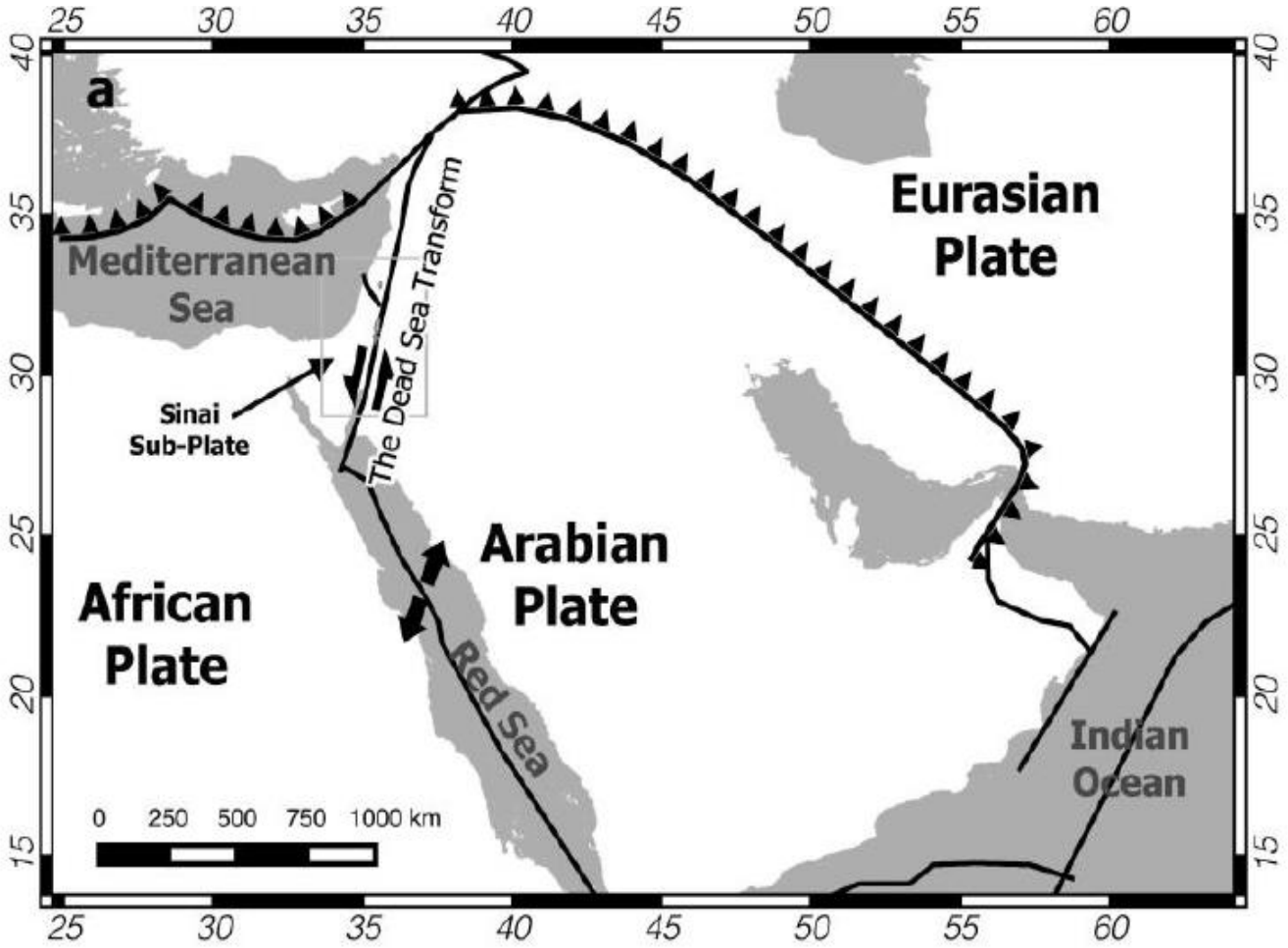


- Earth is on constant motion driven by heat
- Source of heat is the radioactivity within the core
- Temprature gradient across earth layers sets up a flow of heat – heat transfer by convection.
- Convection currents cause movements
- **Movement withing asthenosphere creats movement in lithosphere, (lithosphere plates- tectonic plates)**

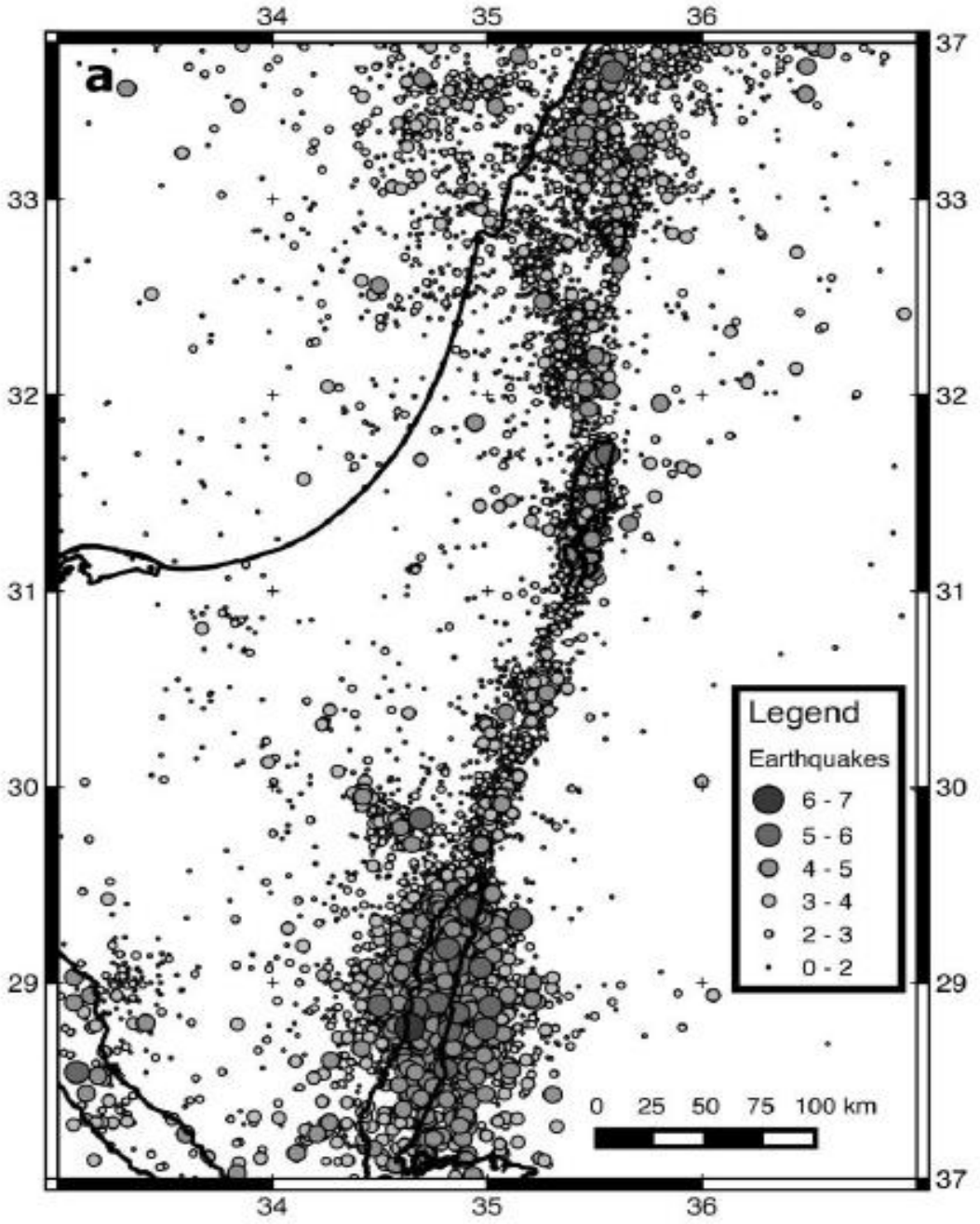
Seismicity of the world: tectonic earthquakes are caused by the sudden dislocation of large rock masses along geological faults within earth‘s crust



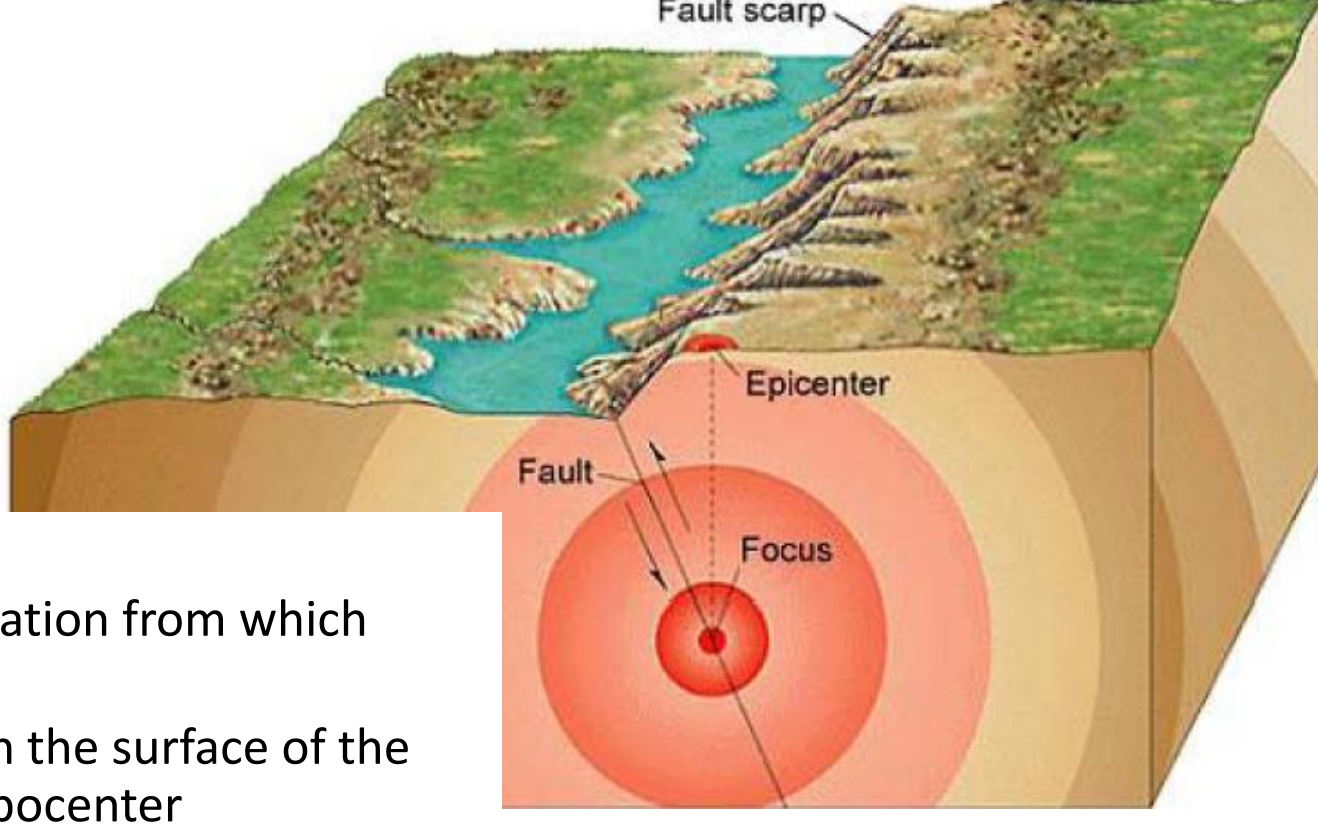
- We are situated along the DEAD SEA Transform (DST), which is a tectonically active plate boundary separating the Arabian plate and the Sinai sub-plate.



- The DST has been generating intensive earthquake activity affecting region, including the destructive Ms 6.2 earthquake in 1927 and the major Mw 7.2 earthquake by 1995.



Terms:



- **Hypocenter (focus):** location from which seismic waves start
- **Epicenter:** projection on the surface of the earth directly above hypocenter
- **Shallow earthquakes:** these earthquakes happen when hypocenter are within the crust
- **Deep earthquakes** are located in the mantle

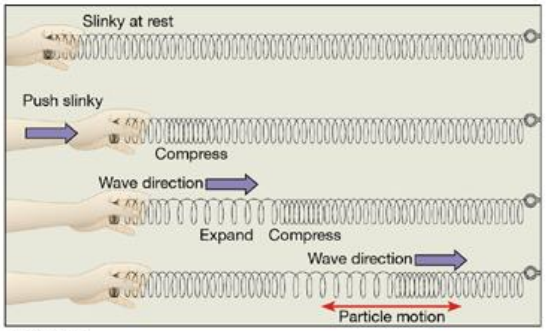
- **Seismic waves:** waves of energy that travel through the earth, and are a result of an earthquake

Seismic waves:

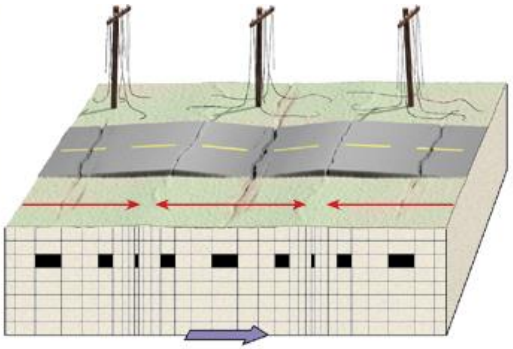
- The stored strain energy of deformation in the rupture zone is released by the earthquake
- This energy is tranformed into heat (friction) and into kinetic energy (seismic waves)
- The seismic waves are a combination of different types
  - Body waves - fastest
    - Longitudinal waves (P waves)
    - Shear waves (S waves)
  - Surface waves - slowest
    - Rayleigh waves
    - Love waves

Types of seismic waves

P wave

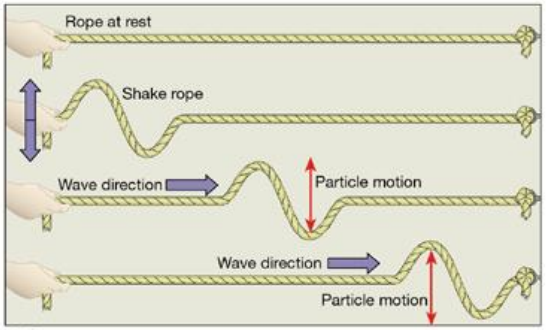


A. P wave

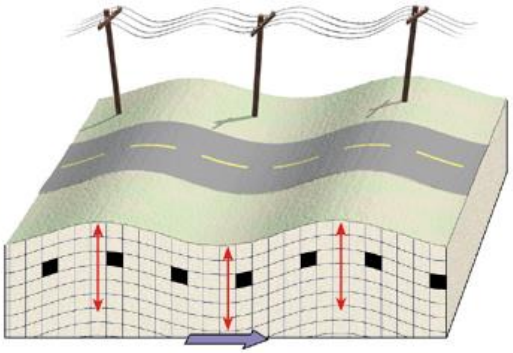


Fast

S wave

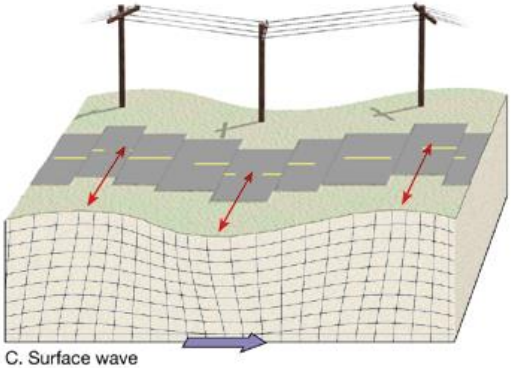


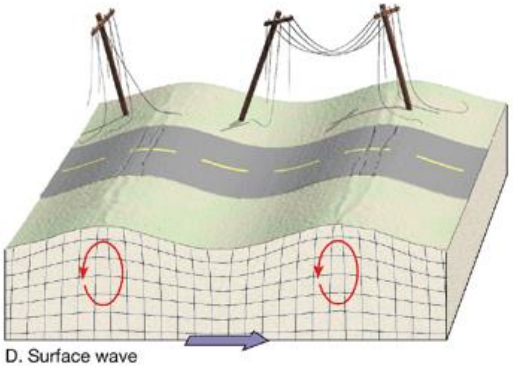
B. S wave



Intermediate

Surface waves


C. Surface wave


D. Surface wave

Slow

Erathquake measurement:

- Earthquake size can be expressed in several ways.

► Intensity

- Qualitative (non-instrumental) measurement.
- Subjective damage evaluation based on description of earthquake effects.

► Magnitude

- Quantitative (instrumental) measurement.
- Objective measure of earthquake size or fault dimensions.

Intensity:

- Discrete scales are used to quantify seismic intensity.
- The levels are represented by Roman numerals and each degree of intensity provides a qualitative description of earthquake effects:

  i. *Mercalli_Cancani-Seiberg* (MCS): 12-level scale used in southern Europe;

  ii. *Modified Mercalli* (MM): 12-level scale used in North American and several other countries;

  iii. *Medvedev-Sponheuer-Karnik* (MSK): 12-level scale developed in Central and Eastern Europe and used in several other countries;

  iv. *European Macroseismic Scale* (EMS): 12-level scale adopted since 1998 in Europe;

  v. *Japanese Meteorological Agency* (JMA): 7-level scale used in Japan.

Different intensity scales:

Magnitude: General comparision

Type	Author	Earthquake Size	Earthquake Depth	Epicentre distance	Reference Parameter	Applicability	Saturation
M_L	Richter, 1935	Small	Shallow	< 600 km	Wave amplitude	Regional (California)	✓
m_b	Gutenberg & Richter, 1956	Small-to-Medium	Deep	> 600 km	Wave amplitude (P-waves)	World-wide	✓
M_s	Richter & Gutenberg, 1936	Large	Shallow	> 2000 km	Wave Amplitude (LR-waves)	World-wide	✓
M_w	Kanamori, 1977	All	All	All	Seismic Moment	World-wide	n.a.

- **The general correlation between magnitude M and A is as follows:**

$$M = \log(A) + f(d,h) + C_S + C_R$$

in which the function f(d,h) accounts for epicentral distance d and focal depth h. The coefficients C_S and C_R are station and regional corrections, respectively.