Earthquake Seismology

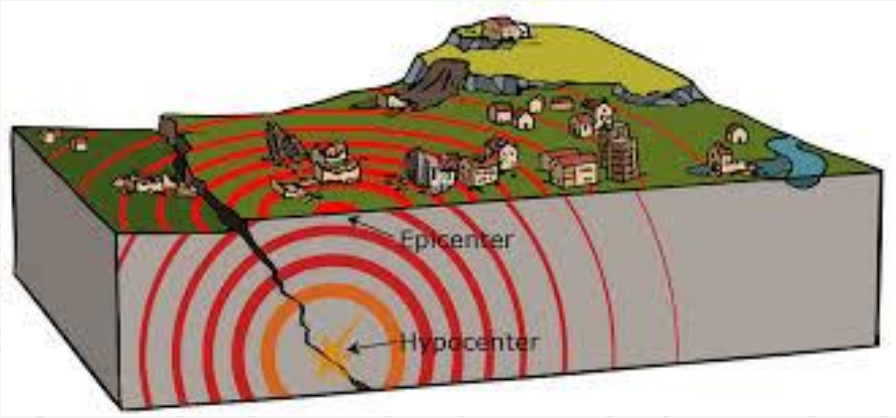
Dr. Ali Attia

Geology and Geophysics Dept.,

King Saud University

Introduction

- **Definitions**
- **Type of seismic waves**
- **Seismic waves and seismogram components**
- **Elastic Rebound theory**
- **Earthquake distributions and plate tectonics**



Definitions should be memorized before starting our course

Seismology	A branch of science focused on the study of earthquakes, seismic activity, and seismic waves
Earthquake	A sudden movement of Earth's crust caused by the release of stress accumulated along geologic faults or by volcanic activity, and released seismic waves.
Seismic waves	Waves of energy caused either by earthquakes, by massive man-made explosions or volcanos. Seismic waves travel through and on top of the surface of Earth causing the shaking and vibrations on the ground. Earthquake waves can travel hundreds of kilometers causing shaking to be felt a long way away from the origin.
Focus or hypocentre	The focus or hypocentre of an earthquake is where the earthquake originated from, usually underground on the fault zone (subsurface).
Epicentre	The epicentre of an earthquake is the point on the surface of Earth directly above the epicentre
Seismometer	An instrument that detects the seismic waves released from earthquakes and/or other ground movements such as explosions.
Seismograph	The device takes the readings produced by a Seismometer and produces a Seismogram
Seismogram	A graph demonstrates seismic waves that looks like a squiggly line

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Foreshocks	Foreshocks are earthquakes of smaller sizes occur in the same area as a larger earthquake (mainshock) that follows. Not all earthquakes have foreshocks or aftershocks.
Aftershocks	Aftershocks are smaller earthquakes that may occur after the mainshock in the same area. They are caused by the area readjusting to the fault movement, and some may be the result of continuing movement along the same fault zone
Earthquake swarm	Sometimes a series of similar sized earthquakes, called an earthquake swarm, happens over months without being followed by a significantly larger earthquake.
Magnitude	Magnitude is a scale used to describe the earthquake size. There are a number of magnitude scale, including the Richter Scale. In Australia, seismologists prefer the use of the moment magnitude scale, which calculates the magnitude of an earthquake based on physical properties such as the area of movement (slip) along the fault plane.
Intensity	Intensity is a scale measures how much damage was done during an earthquake. It is based on what people in the area felt by seismic waves.
Fault plane	A fault is a weak point within a tectonic plate where pressure from beneath the surface can break through and causing shaking in an earthquake.
Lithosphere	All natural earthquakes take place in the lithosphere. The lithosphere refers to the portion of up to 100 kilometers from the surface of the earth.

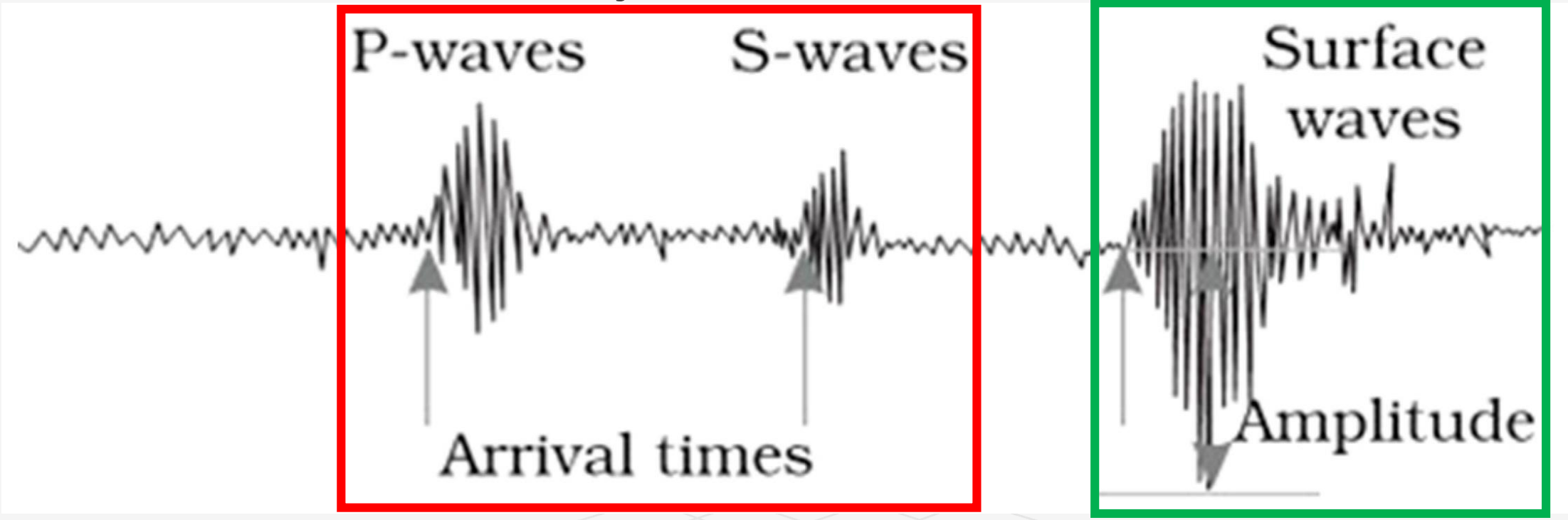
How seismic movement is produced earthquake and seismic waves

The motion we fell on the surface of the earth during an earthquake comes from energy released deep with the earth. This energy is transmitted to the surface by seismic waves. The study of earthquake and seismic energy is called seismology.

Earthquake occur when rocks deep suddenly break under pressure of slip along a fault. The point of release is known as the focus (hypocentre) of the earthquake. The energy released by the earthquake radiates from the focus as body waves.

Type of seismic waves

Body waves



Body waves

There are two types of body waves.

The **first type** is called a **P wave** or **primary wave**, the fastest wave, that moves between four to seven kilometers per second depending on the elastic constants of the rock it's moving through. The P wave is a compression type wave. Rock materials in its direction of propagation compress then expand as the wave passes. The P wave is similar to a wave travelling through a spring. The coils compress and expand in the direction of the wave is travelling.

The **second type** of body wave is called a **S wave** or **secondary wave**. It travels about two to five kilometers per second through rock about half the speed of a P wave. The S wave is a transfer shear wave. Rock materials in its path move up and down or side to side perpendicular to the direction of the waves travel. The S wave is similar to the wave traveling along a piece of rope. The wave moves along the rope by moving a section of the rope up and then down.

Surface Waves

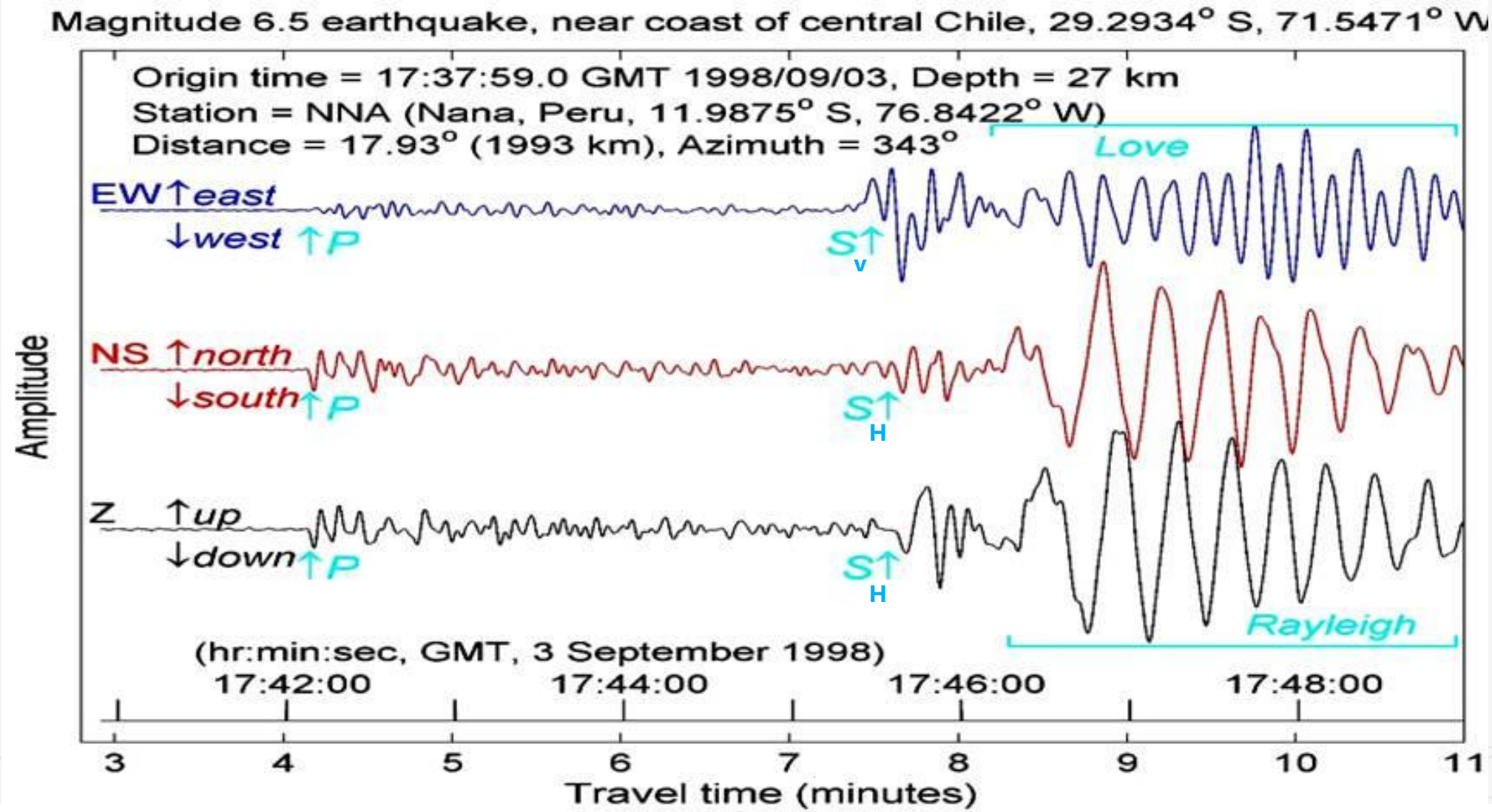
Surface waves radiate outward from the epicentre (the point on the surface above the focus). Surface waves are slower than body waves. They traveling at two to three kilometers per second. The can change the surface of the earth as well as damage resident buildings and other structures. **These waves are more destructive and damaging**.

There are two types of surface waves. The **first type** is the **Love waves** that cause side-to-side motion perpendicular to the direction of wave travel. The Love wave can cause damage by breaking roads and pipes. The **second type** of surface wave is called a **Raleigh wave**. The Raleigh waves move the surface of the earth up forward down and back in a circle. They can cause damage by knocking buildings off their foundations.

In most earthquake, combinations of love and Raleigh waves caused the most destruction because the ground shakes up and down and side-to-side at the same time.

How Surface waves generate?

Seismic waves and seismogram components



How to distinguish between Raleigh and Love wvaes

Using seismograms, you can distinguish between the Raleigh waves and Love waves where Raleigh waves recorded on the vertical component of seismograms while the Love waves recorded on the horizontal components of seismograms (see the previous slide).

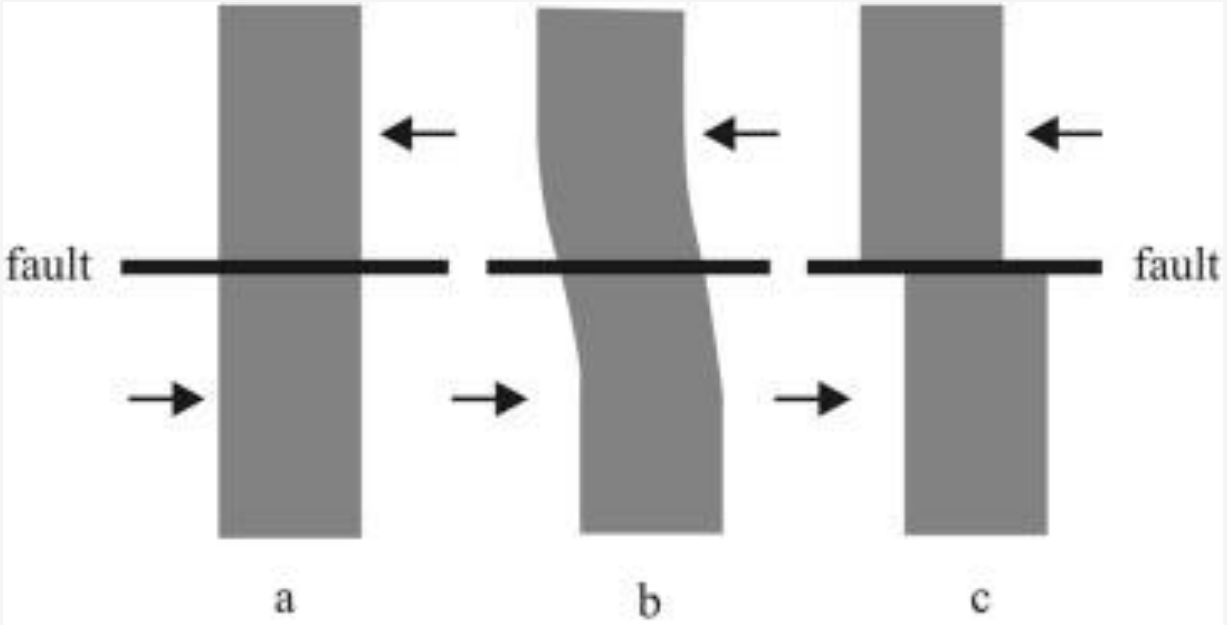
Vertical component (Z) ➔ P + Sv + Raleigh waves

Horizontal components (EW and/or NS) ➔ P + SH + Love waves

Elastic rebound theory

The elastic rebound theory is the theory used by geologists to explain the mechanism of earthquake occurrences. The theory explains how energy is stored in rocks:

- Rocks bend until the strength of the rock is exceeded
- Rupture occurs and the rocks quickly rebound to an undeformed shape
- Energy is released in the form of seismic waves that radiate outward from the hypocentre

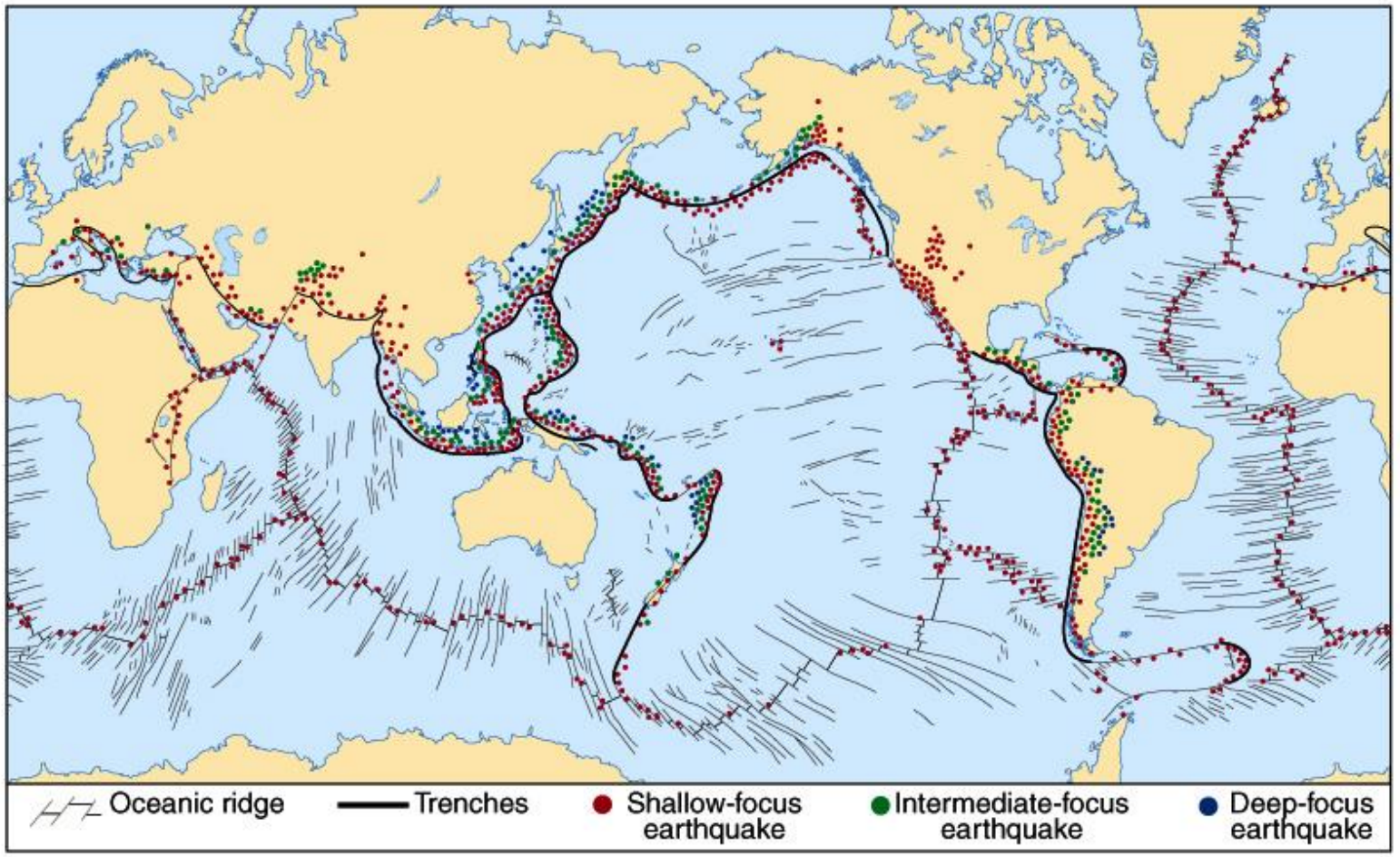


a–No slip potential accumulation

b– Interseismic slip potential accumulation (fault locking)

c– Coseismic slip potential release

Earthquake distributions and plate tectonics



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