

Salahaddin university
Engineering college
Civil department
1st class
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Engineering Geology Earthquake

5th lecture
By: Ali A. Mahmod

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Earthquakes

- **Earthquake**: Vibration of the Earth produced by the rapid release of energy.
- **Seismic waves**: Energy moving outward from the focus of an earthquake.
- **Focus**: Location of initial slip on the fault; where the earthquake originates.
- **Epicenter**: Spot on Earth's surface directly above the focus.

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Earthquakes

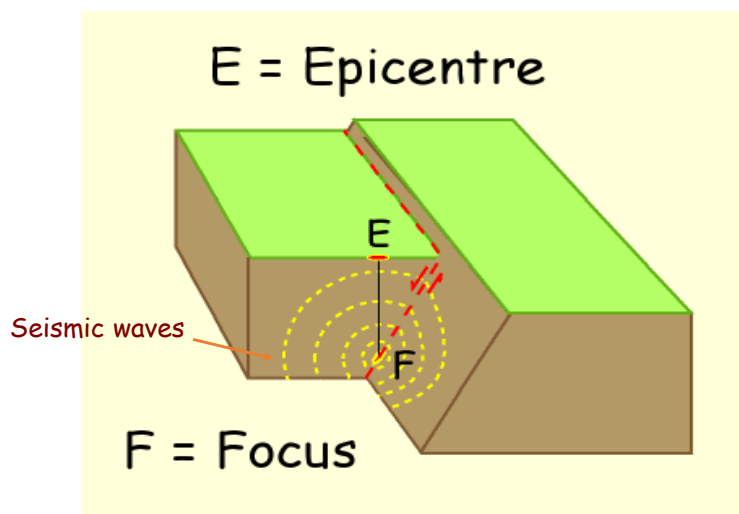


Figure 1

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Seismic Waves

What are Seismic Waves?

Response of material to the arrival of energy fronts released by rupture

Two types:

1. Body waves
 - P and S
2. Surface waves
 - R and L

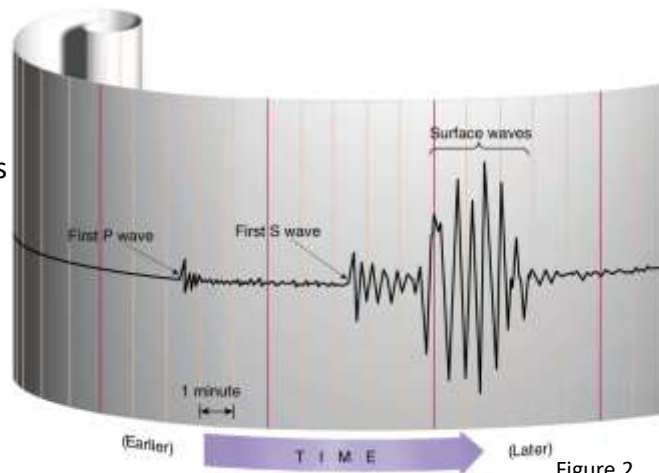


Figure 2

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Seismic Waves

- **P-waves:**
 - called compressional, or push-pull waves.
 - Propagate **parallel** to the direction in which the wave is moving.
 - Move through solids, liquids.
- **S-waves:**
 - Called shear waves.
 - Propagate the movement **perpendicular** to the direction in which the wave is moving.

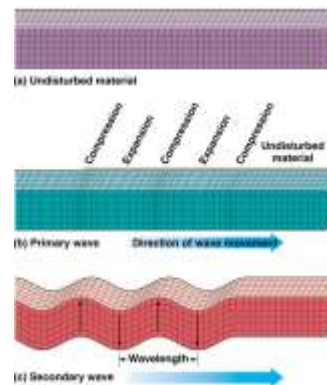


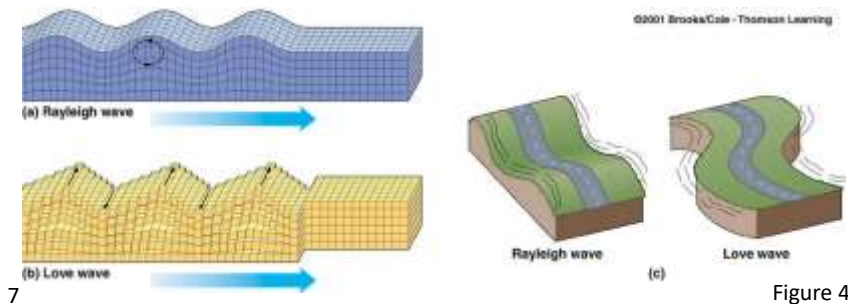
Figure 3

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Seismic Waves

- **Surface waves** (L and R-waves).
 - Complex motion
 - Up-and-down and side-to-side
 - Slowest
 - Most damage to structures, buildings



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Seismic Waves

Seismic waves properties:

Velocity: function of the physical properties of the rock the wave is traveling through.

- Velocity *increases* with rock density.
- Velocity *changes* when passing from one material to another (increases/decreases).

Liquid: S-waves do not get transmitted through liquid; P-waves slow down.

Why is this important?

If we know the velocity of the wave, we can infer the type of rock it traveled through- that's how we map the interior of the Earth.

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Earthquake damage

1. Ground Failure - constructions collapse.
2. Fires - from broken gas and electrical lines.
3. Landslides, dam failures, etc.
4. Liquefaction - water-saturated, unconsolidated materials flow.
5. Tsunami (seismic sea waves; "tidal" waves) - can grow up to 65 m.

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Earthquake damage

Buildings at high risk

1. URM = unreinforced masonry;
2. open lower storeys;
3. poor ties to foundations and between storeys;
4. lack of cross-bracing;
5. poor quality materials.

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Preparedness (examples)

1. Buildings - site selection, design to code, retrofit, upgrade codes.
2. Strengthen bridges, dams, pipelines.
3. Earthquake drills - houses, schools, search & rescue.
4. Emergency planning - survival kits, evacuation routes, fire prevention, utility failures, communication alternatives.

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