Important Properties of Seismic Waves

- **P-waves**
  - Move through solids and liquids

- **S-Waves**
  - Move through solids only

- **Relative Velocities:**
  - P-waves are fastest
  - S-waves are second fastest
  - Surface waves are slowest

Important Properties of Seismic Waves

- The velocity of any seismic wave is directly proportional to the density of the material through which it is traveling
  - If a seismic wave encounters material of higher density, it speeds up
  - If a seismic wave encounters material of lower density, it slows down

What do seismic waves tell us about Earth’s Interior?

- The existence of internal Earth ‘layers’, each characterized by unique density and chemical/mineralogical composition, and identified by a **Seismic Discontinuity**

- **Seismic Discontinuity** – a region in the Earth which is characterized by an abrupt change in seismic wave velocity

Important Seismic Discontinuities

1. Mohorovicic Discontinuity (‘Moho’)
2. Low Velocity Zone
3. 660 km discontinuity
4. Lower mantle – outer core boundary
5. Outer core – inner core boundary

Seismic Discontinuity #1

- ‘Moho’ - crust/mantle boundary
  - Characterized by an increase in seismic wave velocity as seismic energy moves from lower density crustal rock (felsic, mafic) into higher density mantle rock (ultramafic)
    - Depth = 5 to 40 km
Seismic Discontinuity #2

- **Low Velocity Zone** - lithosphere/asthenosphere boundary
  - Characterized by a decrease in seismic wave velocities due to the presence of small amounts of molten rock
    - Molten rock results in lower overall density
    - Amount of molten rock must be very small because S-waves are able to pass through the LVZ
  - Depth = approximately 100 km to 660 km

- **Lithosphere** – includes all the crust and upper parts of the mantle down to the top of the LVZ
  - Cool, brittle
  - Breaks when subject to high stress

- **Asthenosphere** – extends from top of the LVZ to depth = 660 km
  - Hot, plastic
  - ‘flows’ when subject to high stress

Seismic Discontinuity #3

- **660 km discontinuity** – upper mantle/lower mantle (mesosphere) boundary
  - Abrupt increase in seismic wave velocity
    - Transformation of minerals under very high pressures into densely compacted arrangements of atoms, resulting in rock of higher density
    - Pressures are too high for molten silicate material at depths greater than 660 km
**Seismic Discontinuity #4**

- Lower Mantle/Outer Core Boundary
  - Abrupt decrease in P-wave velocities
  - S-waves stop
    - P- and S-waves move from very dense rock in the lower mantle into molten material of lower density in the outer core

**Seismic Discontinuity #5**

- Outer Core/Inner Core Boundary
  - Abrupt increase in P-wave velocities
  - S-waves ‘reappear’
    - Seismic energy moves from molten outer core into higher density solid inner core
Seismic Shadow Zones - provide additional seismic evidence for a layered earth

- **P-wave shadow zone**
  - Extends from ~105° to 140° from epicenter
  - No P-waves detected
  - Due to refraction (bending) of P-waves at lower mantle/outer core boundary

- **S-wave shadow zone**
  - No S-waves and no P-waves detected
  - Extends over all regions greater than 105° from epicenter
  - Due to inability of S-waves to pass through liquid outer core

Meteorites – provide evidence of Earth’s internal composition

- Most meteorites are either:
  - ‘stony’ meteorites – have chemical compositions very similar to rocks which make up Earth’s mantle
  - metallic meteorites – have chemical compositions very similar to material which makes up Earth’s core

- Supports theory that Earth’s mantle is ultramafic in composition and Earth’s core is primarily composed of iron + nickel

Earth’s Electromagnetic Field – supports theory that outer core is metallic melt and inner core is metallic solid

Stony Meteorite
Similar in composition to Earth’s mantle (mafic)

Metallic Meteorite
Considered similar in composition to Earth’s core (Fe + Ni)
Charged particles moving around a stationary metallic body creates an electromagnetic field.