Geology 1001.4

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EXPLORING EARTH'S INTERIOR

Journey to the Center of the Earth

- **What we know about the Earth's interior, comes from analysis of speeds of seismic waves**

  - waves travel:

  - waves detected at various locations change velocity

  - therefore Earth is:

- **Seismic waves can be used to infer the structure and composition of the Earth and the transitions that mark boundaries**

  1. **P and S waves travel through specific materials at specific velocity**

  2. **Recall: P waves =**

     move faster thru

  3. **S waves =**

4. **P waves travel through**

   S waves travel only through

5. **their travel velocity depends on the material**

   $velocity = \frac{time}{distance}$

6. **time variations for different paths are used to infer properties of materials through which waves passed**

- **Change in velocity of P and S waves as they pass through media of different elasticites determine path thru interior**

- **Based on principles of sound (analogous to light) propagation;**

  when an interface between two materials is encountered:

  1. **<u>reflection</u> -**

     due to differences in wave velocity thru materials

  2. **<u>refraction</u> -**

     - wave velocity is proportional to the properties of materials

3. If Earth were made of a single composition,
   - waves would
   - from the focus thru the interior to the seismograph.

   P waves travel in a curved path.

4. How P and S waves are reflected and refracted provide information on the structure of the Earth (e.g. sonar)

5. Shadow Zone - a zone where no P or S waves reach the surface because of

   (a) P Wave Shadow Zone - from 105-142 degrees,

   (b) S Wave Shadow Zone - no S waves received more than

   never emerge from other side, ergo not transmitted.

   S-waves do not pass thru outer core because

6. The existence of the P shadow zone suggested that the core was a made of a different material; bending of the waves downward suggested a liquid.

   Confirmed by S-waves,

7. Distance to material interface is calculated based on round trip travel times

- Seismic waves are also used for oil exploration.

COMPOSITION and STRUCTURE of EARTH'S INTERIOR

- **Velocity of P and S waves as a function of depth within the Earth.**

- **This lead to the geologic interpretation of the Earth's Structure when combined with high pressure - high temperature experimental studies.**

  - **Earth's composed of three concentric layers:**

    1. **thin outer**

       - 0 - km = crust

    2. **large underlying**

       - km

    3. **central**

       - 2900 - 5100 =
       - 5100 - 6370 km =

1. **<u>CRUST</u>**

   - **thin rigid zone; rocky outer segment, composed of**

- varies in thickness depending on

- Continental Crust:
  - usually less than

  - average of

  - ca. 65-100 km

- Oceanic Crust:
  - uniform composition, gabbro;

  - 0-10 km

- Seismic wave velocity varies as a function of rock composition:
  - felsic =
  - mafic =
  - ultramafic =
- Continental crust is primarily

  floored by

  Oceanic crust is

2. Mohorovicic discontinuity - boundary between

   - Abrupt discontinuity between crust and mantle based on abrupt change in seismic wave velocity (reflecting

3. MANTLE

(a) largest segment of

(b) planet's volume =

(c) extends to

(d) velocity changes indicate three divisions

(e) Upper Mantle - (10) 65 (100) - 400 km;

(f) Low-velocity Zone - rocks

P waves decrease

(g) Transition zone -

too great an increase in S vel for composition; therefore must be a change in

- structure

(h) 450 - 670 km;

(i) 670 - 700 km; _____zone

(j) Lower Mantle-

(k) Core-Mantle Boundary - ca.

4. CORE

(a) larger than planet

(b) radius of

(c) consists of

(d) one-sixth of total _____; one-third of _____

(e) Outer Core -

(f) Inner Core -
Fe with 20% S
T = 7600C P wave increase

5. LITHOSPHERE and ASTHENOSPHERE are structural boundaries; rheologic layers

- Lithosphere
  - consists of
  - solid and cold
  - from Moho to ca.
  - extends to (10) 65 (100) km
    (shallower under ridges; deeper under mtns)
  - hits the
  - plates are fragments of
  - boundary marked by drop in

- Asthenosphere
  - behaves

- **extends to from base of**
- **solids with small amounts**
- **zone of**
- **low velocity zone - S wave velocity drops due to mix of solid and liquid**

- **Velocity in both litho and athenosphere fit _____composition**