

ES.103 – PROBLEM SHEET 1

Problem 1.1 Some background questions (you might want to read Fowler or consult your earth50 notes if these terms seem mystical!):

- Define the following terms used in plate tectonics: "sea-floor spreading", "ocean ridge", "transform fault", "subduction zone".
- The mantle and core are made out of different materials – what are they?
- Define what is meant by "lithosphere" and "asthenosphere"
- Which is thicker: oceanic or continental crust? Why?

Problem 1.2

- A mode of oscillation has a period 10 minutes, what is its frequency in mHz?
- There are two kinds of surface waves, what are they called and which one don't you see on a vertical component seismogram?
- There are two kinds of body waves, what are they called and which one travels fastest?
- What do we mean by the "radial" and "transverse" directions?
- Which body wave has no motion in the "transverse" direction.

Problem 1.3 The elastic properties of an isotropic elastic solid are completely described by the density ρ , the bulk modulus K_s and the shear modulus or rigidity, μ . An alternative description is in terms of ρ , λ and μ where λ and μ are called the Lamé parameters and

$$\lambda = K_s - \frac{2}{3}\mu$$

A convenient dimensionless ratio (which measures the ratio of lateral contraction to elongation when a bar is stretched) is Poisson's ratio, σ , given by

$$\sigma = \frac{\lambda}{2(\lambda + \mu)}$$

If $\lambda = \mu$, the solid is said to be a Poisson solid.

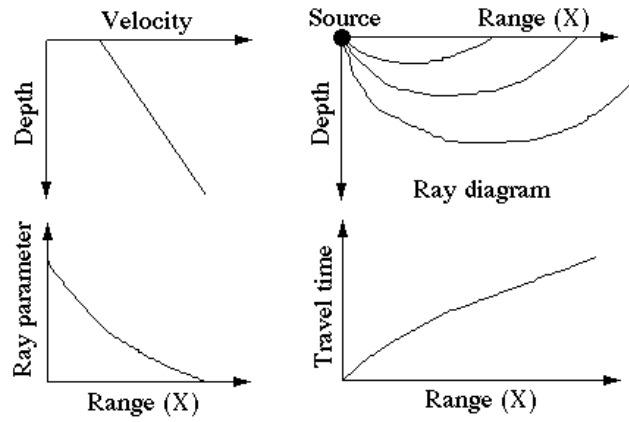
If the mantle is a Poisson solid, what is the value of σ , and how much faster do P waves travel than S waves?

What is the value of σ in the outer core of the Earth?

Problem 1.4 Suppose t is time, x is distance and c is velocity. Show that any function of the combined variable $t - x/c$ is a solution of the 1-dimensional wave equation. (This corresponds to an arbitrary disturbance which propagates without change in shape.)

Problem 1.5 S-waves are observed to an epicentral distance of about 103° on the Earth (but no further because of the presence of the fluid core). Assuming that the S-wave velocity is constant throughout the mantle, compute the ratio of the core radius to the total radius of the Earth. What is the observed ratio and why is your answer different from it?

Problem 1.6 An example of a ray diagram, $T(X)$ and $X(p)$ are shown in the following diagram for a linearly increasing velocity structure:



Complete the equivalent diagrams for the following structure and sketch $\tau(p)$ where τ is the delay time.

