Resit Exam Introduction to Seismology and Seismics, Part 1

31 January, 2013, 13:30-16.30

1. (a) Give an example of a strain tensor representing a volume increase with only two non-zero elements. Illustrate the associated deformation with a sketch.
   (b) Give an example of a strain tensor representing shear strain with only two non-zero elements. Illustrate the associated deformation with a sketch.

2. A displacement field
$$\mathbf{u}(\mathbf{x}, t) = \mathbf{A} \sin(\omega t - \mathbf{k} \cdot \mathbf{x})$$
satisfies the wave equation
$$\nabla^2 \mathbf{u} = \frac{1}{v^2} \frac{\partial^2 \mathbf{u}}{\partial t^2}$$
where $\mathbf{u} = (u_1, u_2, u_3)^T$, $\mathbf{x} = (x_1, x_2, x_3)^T$, $\mathbf{A} = (A_1, A_2, A_3)^T$, and $\mathbf{k} = (0, k_2, 0)^T$.
   (a) What do $\mathbf{A}$, $\mathbf{k}$, and ω represent?
   (b) Which relationship do you find when you substitute $\mathbf{u}$ in the wave equation?
   (c) If $\mathbf{u}$ represents a S-wave, what does this imply for the components of $\mathbf{A}$?
   Show this by calculating the divergence or curl of $\mathbf{u}$.

3. State Snell's law, Fermat's principle, and Huygens's principle.

4. See the figure below.
   (a) Find the travel time $T_d(x)$ of the head wave in the downdip direction of the interface in terms of h_d, v_0, v_1, θ, and i_c. (Show how you obtain your result. Full simplification of the expression is not required.)
   The expression is found to be equal to
$$\begin{aligned} T_d(x) &= \frac{x \sin(i_c + \theta)}{v_0} + \frac{2h_d \cos i_c}{v_0} \\ &= \frac{x}{v_d} + \tau_d \end{aligned}$$
   (b) Give the equivalent relations for the head wave in the updip direction.
   (c) If a reversed profile is conducted, how can you obtain the dip angle θ and the seismic velocities v_0 and v_1 from the data?