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PHYSICS FOR A BETTER PLANET – II EDITION

EXPLORING THE SUBSURFACE (WITH A HAMMER...): SEISMIC REFRACTION

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EXPLORING THE SUBSURFACE (WITH A HAMMER...): SEISMIC REFRACTION

LABORATORY ACTIVITY: INSTRUCTIONS

The laboratory activity will consist of estimating the characteristics of the soil in a simplified configuration (INCLINED DISCONTINUITY) using travel time data and seismic refraction theory.

STEPS:

1. Download the two datasets: 101.dat (direct path) and 102.dat (conjugate path), containing the source-receiver distance (in m) and the travel time (in s).
2. Plot the respective dromochrones (see graph in slide 3).
3. Estimate the parameters of the lines fitting the survey datasets through Excel, code programming (formulas for least squares in slide 4), or drawing directly on paper.

$$\begin{cases} t = a_D x \\ t = b_D x + c_D \end{cases}$$

$$\begin{cases} t = a_U x \\ t = b_U x + c_U \end{cases}$$

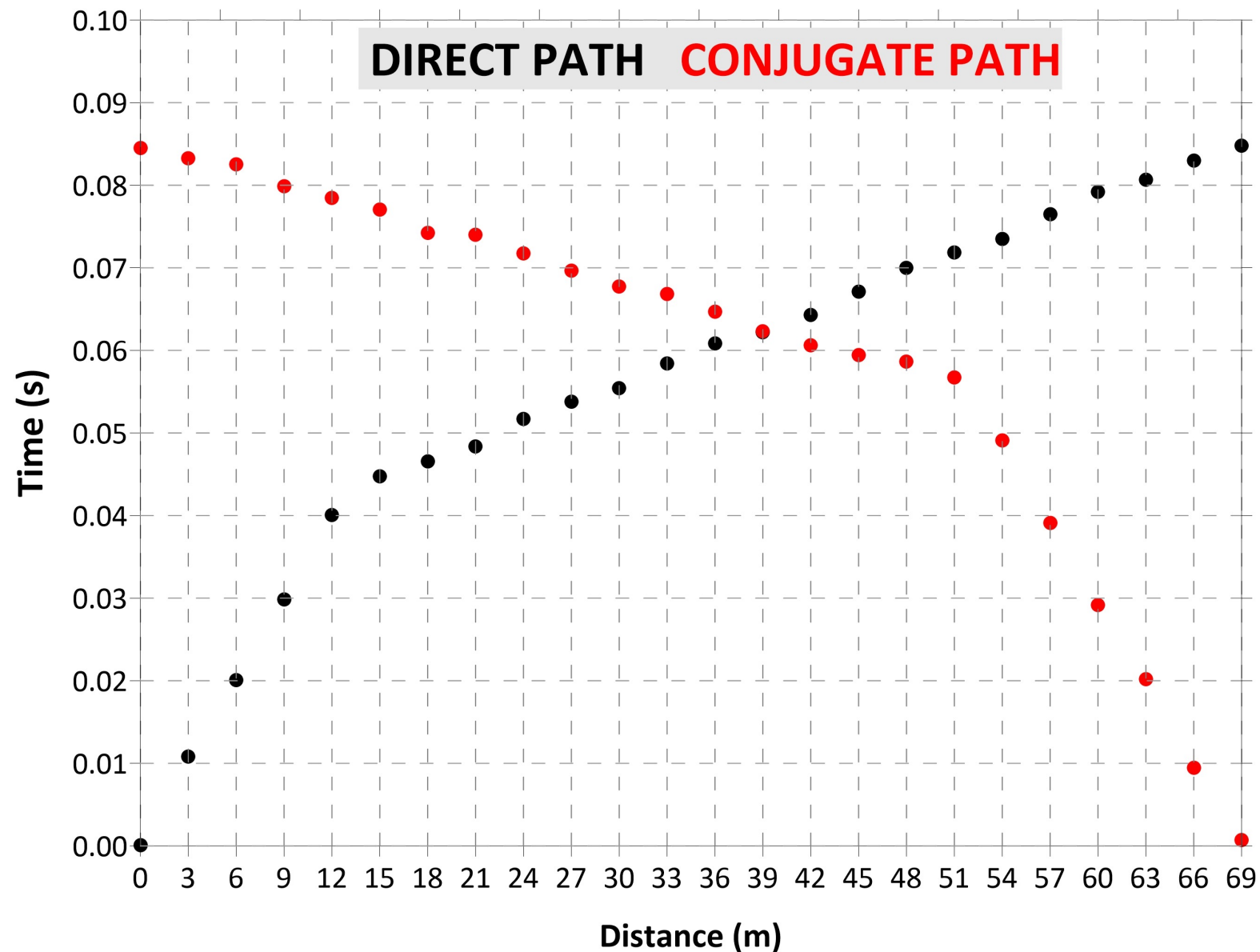
(!!! Pay attention to the determination of the fit-line parameters for the conjugate path).

4. Apply the formulas (reported in slide 5) to determine the subsoil parameters: v_1 , v_2 , H_1 , H_2 and θ .



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LEAST SQUARES FORMULAS

Starting dataset: $[x_i, t_i], i = 1, \dots, N$

LINE $t = ax$

$$a = \frac{\sum_i t_i x_i}{\sum_i x_i^2}$$

LINE $t = bx + c$

$$b = \frac{N \sum_i t_i x_i - (\sum_i x_i)(\sum_i t_i)}{N \sum_i x_i^2 - (\sum_i x_i)^2}$$

$$c = \frac{(\sum_i t_i)(\sum_i x_i^2) - (\sum_i t_i x_i)(\sum_i x_i)}{N \sum_i x_i^2 - (\sum_i x_i)^2}$$



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Formulas for the determination of the subsurface model (INCLINED DISCONTINUITY)

$$v_1 = \frac{1}{2} \left(\frac{1}{a_D} + \frac{1}{a_U} \right)$$

$$\theta = \frac{1}{2} [\arcsin(b_D v_1) - \arcsin(b_U v_1)]$$

$$v_2 = \frac{2 \cos \theta}{b_U + b_D}$$

$$\delta_{CR} = a \sin \left(\frac{v_1}{v_2} \right)$$

$$H_1 = \frac{v_1 c_D}{2 \cos \delta_{CR}}$$

$$H_2 = \frac{v_1 c_U}{2 \cos \delta_{CR}}$$

