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REFLECTION RAY TRACING IN LIGNITE SEAM MODEL

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ABSTRACT. Lignite is a main energy s
countries. Therefore a great attention is devoted to the exploration of lignite deposits. Expensive drilling boreholes is supplemented by relatively cheaper seismic reflection measurements.

Numerical modelling of seismic wavefields may influence the measurement technique and interpretation of the measured data. Reflection ray tracing method was used to study the propagation of reflected P waves in faulted lignite seam model.

1. INTRODUCTION

Geological situation in lignite coal basins is frequently complex due to fault systems and lens–shaped concretions at particular horizons. These inhomogeneities have a negative influence on the open–pit mining works [Tselentis 1995]. So the results of a detailed seismic reflection exploration combined with the borehole results are very valuable and useful, both for the excavation of the deposits and for the accurate estimate of the amount of resources. Well performed seismic survey will save a number of expensive drilling boreholes.

The aim of this paper is to use the algorithms and routines proposed by [Červený, Klimeš & Pšenčík 1988] for building the simple velocity model of lignite seam and for computation of reflected P waves by the ray method.

2. LIGNITE SEAM MODEL

Faulted lignite seam velocity model, that represents possible situation in lign basin, is studied. Parameters of the model are summarized in Table 1 and the model is plotted at figures 1 – 4. There are different values of thickness left and right to the fault for upper bed and bottom layer. Cartesian co–ordinate system was used with the origin at the upper left corner of the model. X_1 co–ordinate points rightwards, X_2 co–ordinate is constant and X_3 co–ordinate points downwards. Size of the model is $X_{1\,\mathrm{min}} = 0$, $X_{1\,\mathrm{max}} = 400$, $X_{3\,\mathrm{min}} = 0$, $X_{3\,\mathrm{max}} = 100$ [m].

The coal seam and the bottom layer are dislocated by a fault with the following parameters:

a) corner point of the fault is at the co–ordinates $X_1 = 50$, $X_3 = 60$ [m],
b) coal seam is shifted 10 m downwards by the fault,
c) the slope of the fault is defined by the relation $\triangle X_3 / \triangle X_1 = 2/1$.

TABLE 1.

layer (complex block)	*thickness* [m]	*P wave velocity* [m/s]
surface layer (CB1)	10	500
upper bed (CB2)	50, 60	2800
coal seam (CB3)	15	1400
bottom layer (CB4)	25, 15	2800

Numerical description of the velocity model was performed by the means described by [Červený, Klimeš & Pšenčík 1988]. Figures 1 – 4 show the physical units of the model, complex blocks (CB). The complex blocks, that constitute the model, are limited by the boundaries of the model and interfaces.

3. Reflection Ray Tracing

Ray paths and travel times of reflected P waves were computed using the FORTRAN77 subroutine packages MODEL and CRT [Klimeš 1994]. Figures 1 – 4 show rays and travel times in the lignite seam model. The figures also illustrate the measurement geometry. Two sources located at the surface ($X_3 = 0$) were used. The first source has coordinate $X_1 = 0$ and the second source $X_1 = 108$ [m]. The second source was located at the position where the rays from the first source were not found. Ray quantities were computed for 120 receivers located at the surface with interval of 3 meters and the first receiver had co-ordinates $X_1 = 3$, $X_3 = 0$ [m]. Figures 1 – 4 were plotted by FORTRAN computer program that utilizes GKS graphic library [Konopásková, Bucha 1996].

4. Discussion

Reflections of P waves in the simple lignite seam model were computed. The first results show, that it is possible to use MODEL and CRT subroutine packages for such computations. In the next step more complex models and measurement geometries will be studied. Computed theoretical ray quantities should influence parameters of field measurements and help to interpret the measured data.

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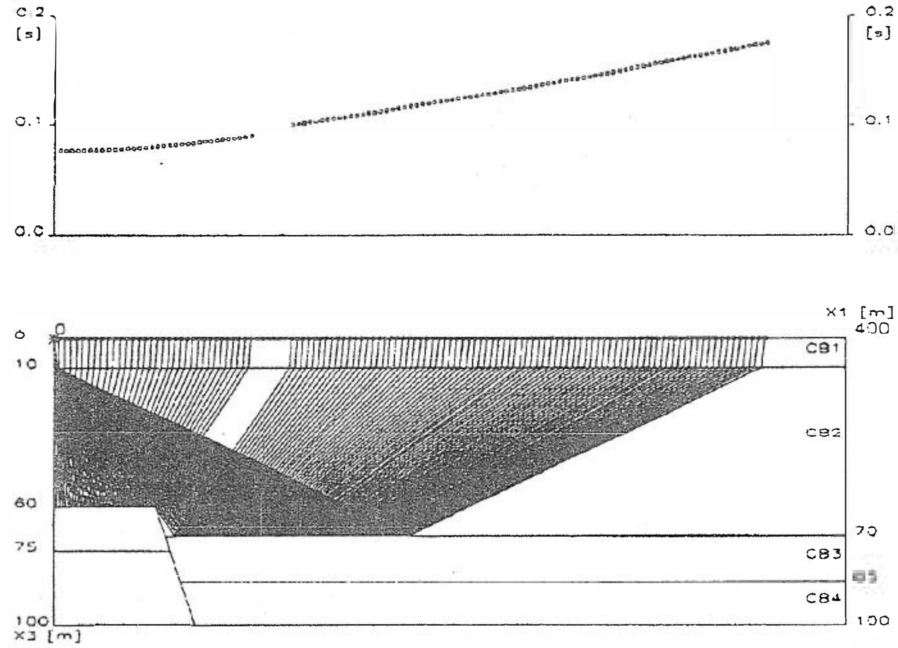

FIG. 1. Computed ray paths and travel times of P wave reflected by the coal seam in lignite seam model. Co-ordinates of the source are $X_1 = 0$, $X_3 = 0$ [m].

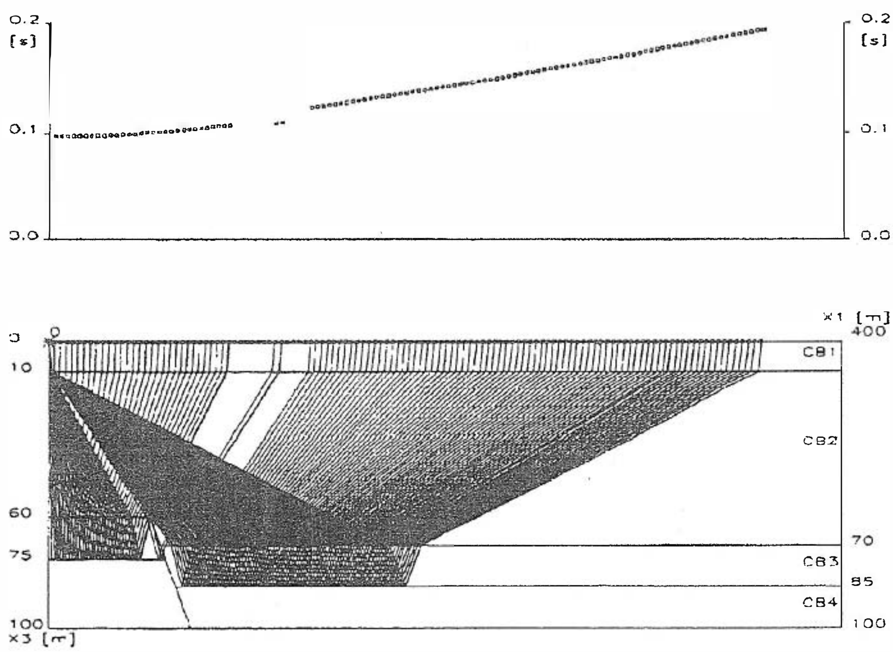

FIG. 2. Computed ray paths and travel times of P wave reflected by the bottom layer in lignite seam model. Co-ordinates of the source are $X_1 = 0$, $X_3 = 0$ [m].

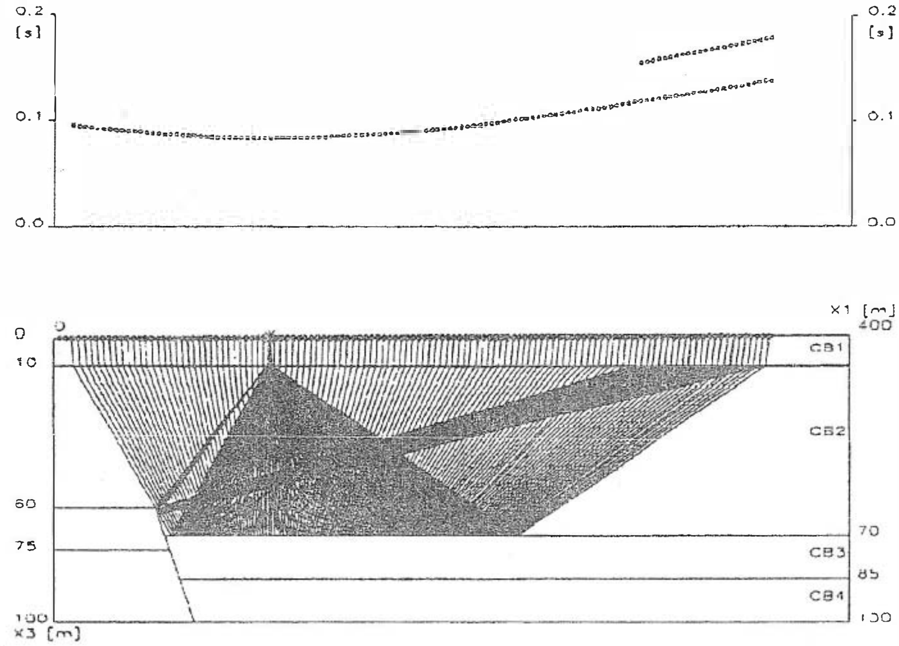

FIG. 3. Computed ray paths and travel times of P wave reflected by the coal seam in lignite seam model. Co–ordinates of the source are $X_1 = 108$, $X_3 = 0$ [m].

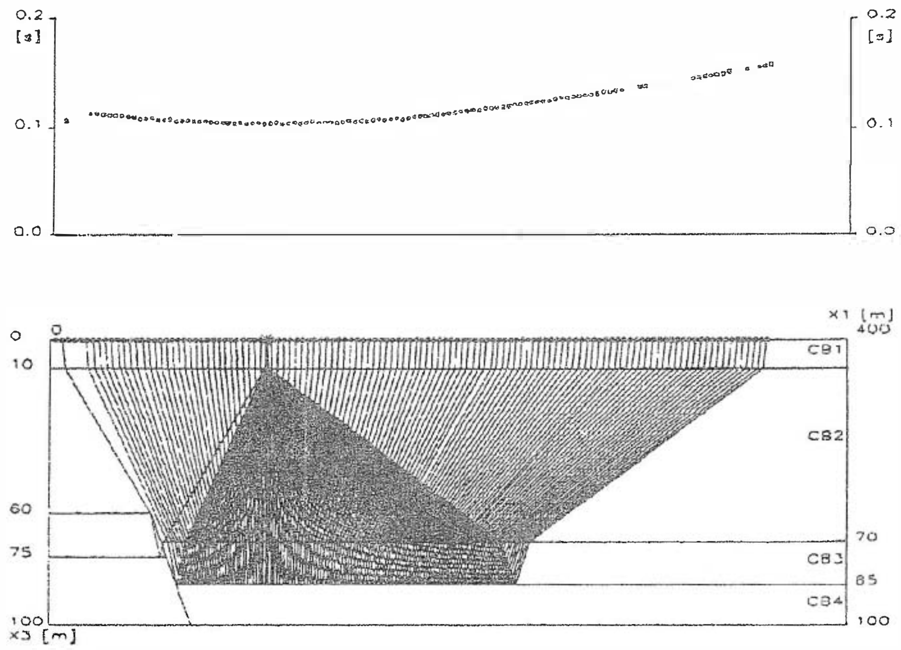

FIG. 4. Computed ray paths and travel times of P wave reflected by the bottom layer in lignite seam model. Co–ordinates of the source are $X_1 = 108$, $X_3 = 0$ [m].

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