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VELOCITY DISTRIBUTIONS IN THE UPPER CRUST OF THE EASTERN PANNONIAN BASIN

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Abstract

We processed seismic reflection data recorded in projects performed for hydrocarbon exploration in areas from Eastern Pannonian Basin. We obtained stacking velocities with high and low accuracy, depending on the signal-to-noise ratio (S/N) of the seismic data. Interval velocities in time and depth were computed using stacking velocities. Two- (2D) and three-dimensional (3D) velocity distributions were built for the upper crust of the Eastern Pannonian Basin at time intervals of 0.250 s and depth intervals of 250 m.

Introduction

Information about the velocity distribution into the subsurface can be obtained after the processing of the seismic reflection data (interactive velocity analysis performed on filtered common-depth gathers, CDP-gathers) or after the inversion of the first-arrival traveltimes picked on common-source gathers recorded in seismic reflection or refraction surveys (Ylmaz, 2001; Bocin et al., 2005; Hauser et al., 2007). The velocity models accuracy depends on the S/N of the seismic data, which is an effect of the errors performed during data acquisition (e.g. generation of seismic energy at smaller depths than the designed ones, rough topography, irregular geophone and source spacings etc). The effect of rough topography and variations of near-surface parameters can be removed by applying static corrections; refraction interferometry can be used to improve the first arrivals and, therefore, the accuracy of the static corrections with effects on the frequency filtering and interactive velocity analysis (Panea and Bugheanu, 2016).

Description of the seismic reflection data

We processed a number of 22 seismic datasets. The total length of the analysed lines is about 300 km; the distribution of the seismic lines is displayed in Figure 1. All 22 seismic datasets were recorded during 1990-1999, meaning that the seismic measurements were performed using a small number of geophones. The data acquisition was done using 48 geophones spaced at 50 m or 96 geophones spaced at 25 m. The coherent noise seen on the records obtained using geophones spaced at 50 m is strongly spatially aliased. The seismic energy was generated using explosive sources (dynamite). The source spacing was 50 m, for geophone spacing of 25 m, and 100 m, for geophone spacing of 50 m. The time sampling interval was 0.002 s. Record length was greater than 4 s for all analysed seismic datasets. Examples of seismic records with low and high S/N are displayed in Figure 2. The record with low S-N has 48 traces spaced at 50 m. Most of the seismic energy was propagated as surface waves. The record with high S/N has 96 traces spaced at 25 m. The surface wave body is clear at small offsets with respect to the shot point. The reflected waves are clear on the analysed time interval without any processing steps applied; automatic gain control was applied using a window of 250 ms for a better display. On both displayed records, the first arrivals are clear along the entire geophone spread, meaning that the static corrections can be computed with high accuracy.

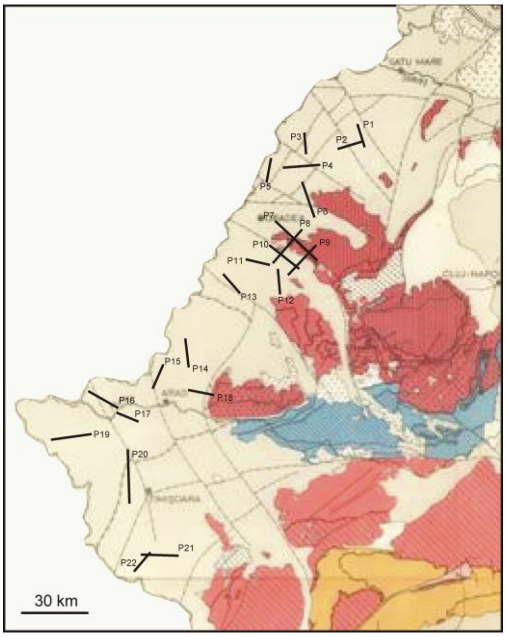

Figure 1: Tectonic map of the Eastern Pannonian Basin showing the position of the seismic lines (modified from Sandulescu, 1984).

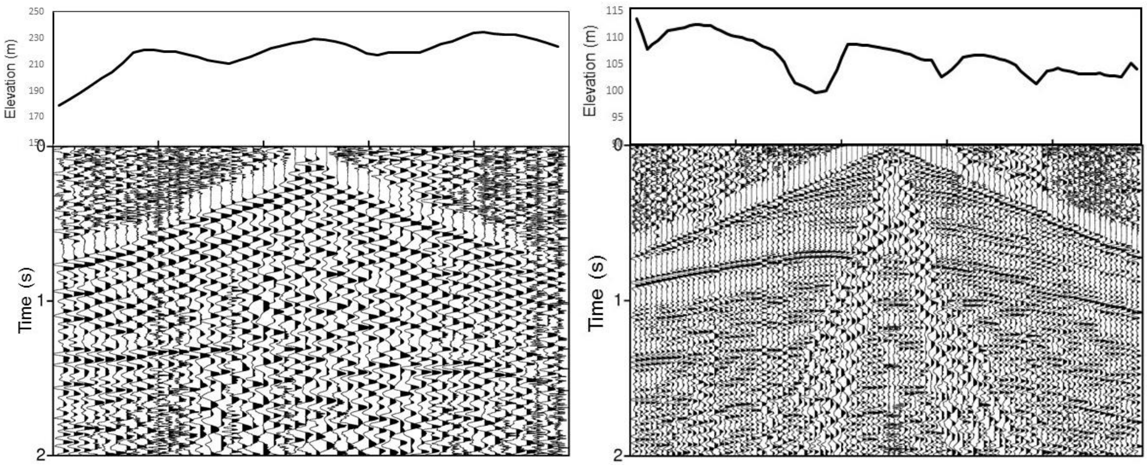

Figure 2: Seismic records with low (left) and high (right) S/N. Black line – elevation profile.

Description of the data processing

Data processing was done to obtain 2D and 3D P-wave velocity distributions. The seismic records were loaded in the SEG-Y format. The geometry was defined for linear profiles. The static corrections were computed for a final datum of 0 m and various replacement velocity values, depending on the data. The coherent noise was removed/attenuated by filtering (band-pass frequency filter, fk filter, spiking deconvolution). Amplitude corrections and trace editing were used during processing, when needed. Interactive velocity analysis combined with Normal Move-Out (NMO) correction was used to determine stacking velocities. Figure 3 shows the picking of stacking velocities and interval velocities in time before and after the NMO correction. Interval velocities in time varied from one group of reflections to another (Figure 3). Interval velocities in depth were obtained from interval velocities in time, after some editing. We display in Figure 4, the 2D stacking velocity distributions obtained along the lines P8 and P21. The 2D distributions with interval velocities in depth obtained along these lines are displayed in Figure 5. The low velocity values correspond to the sedimentary deposits, while higher velocities were obtained for the basement. The 3D velocity distributions for stacking velocities, interval velocities in time and depth were obtained after the interpolation of all 22 2D velocity distributions (not displayed here). Stacking of traces and time migration were used to verify the accuracy of the picked velocities.

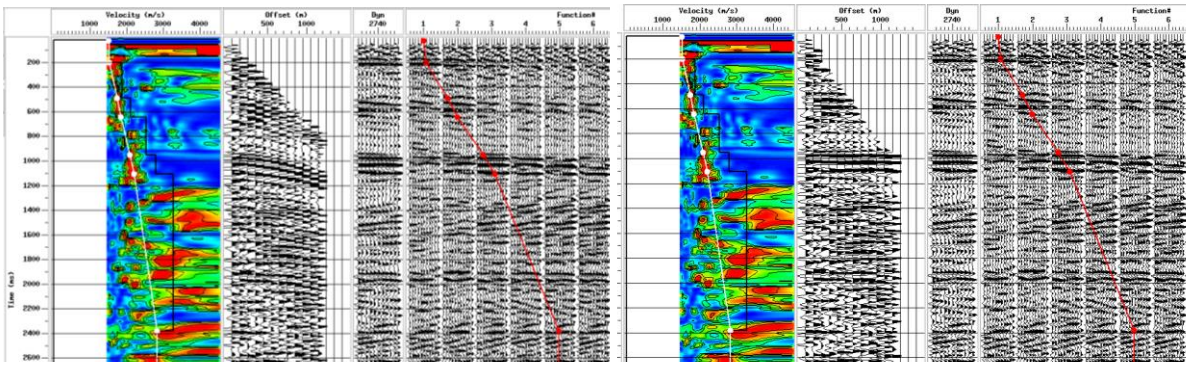

Figure 3: Interactive velocity analysis without (left) and with (right) Normal Move-Out corrections applied; white line – stacking velocities, black line – interval velocities in time.

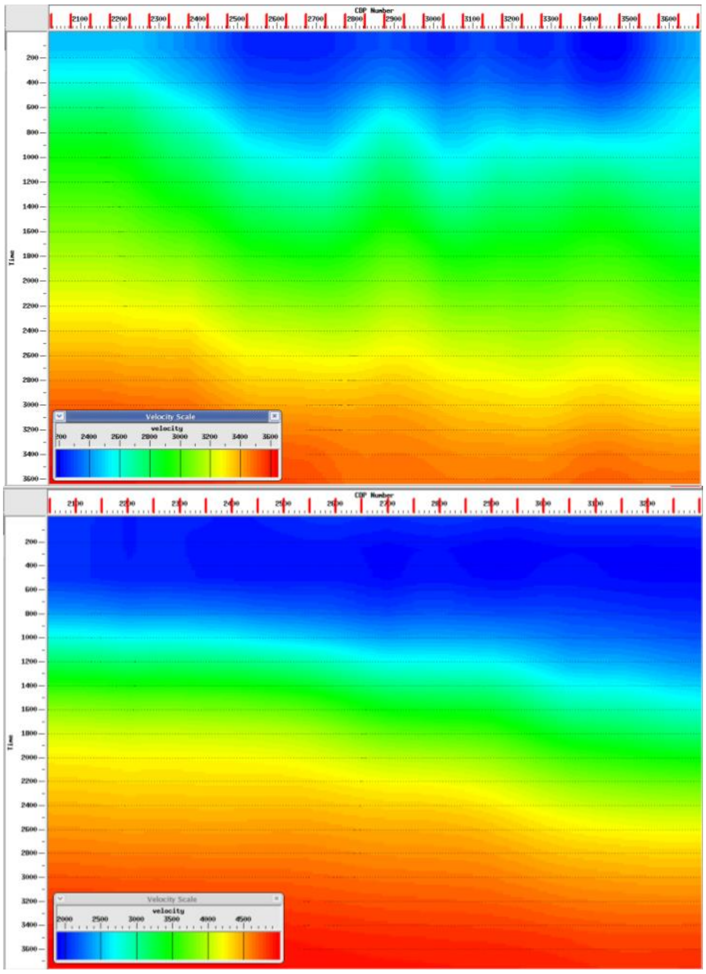

Figure 4: Stacking velocities along the line (up) P8 and (down) P21.

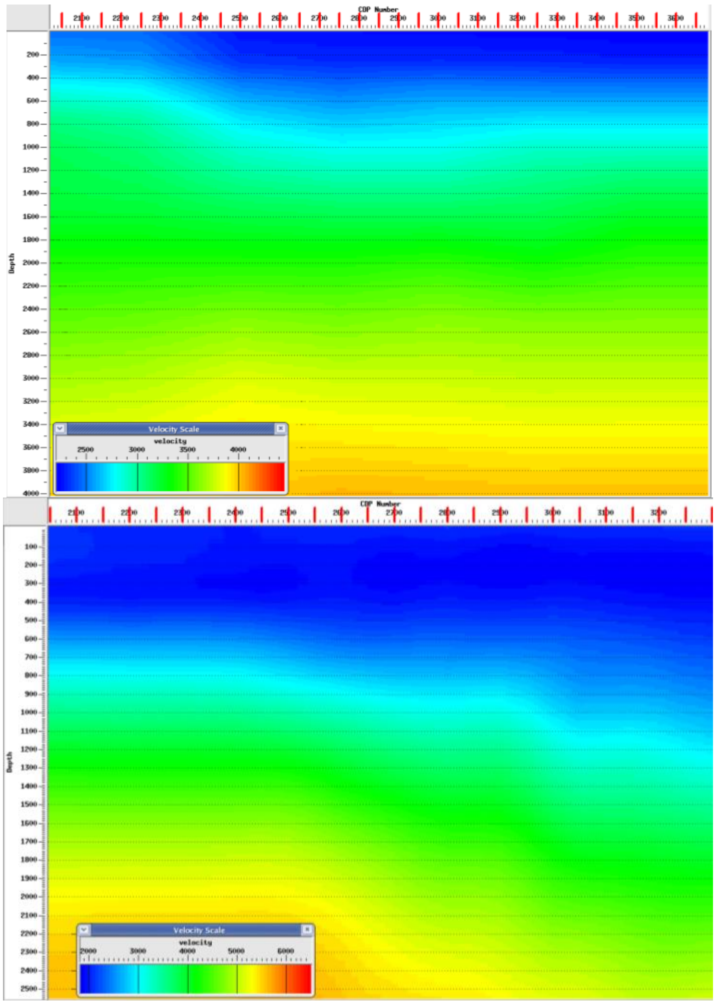

Figure 5: Interval velocities in depth along the line (up) P8 and (down) P21.

Conclusions

We processed 22 seismic reflection datasets to obtain 2D and 3D dstributions for stacking velocities, interval velocities in time and depth. The accuracy of the velocity values was affected by the presence of low S/N records. Most of the velocity models show a good correspondence between the geological structure (e.g. shape of sedimentary deposits, uplifted basement blocks) and velocity distribution into the subsurface.

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