

3D REFRACTION TOMOGRAPHIC IMAGES FROM THE MATRA-ZEMPLEN REGION

E. HEGEDŰS, K. POSGAY, T. BODOKY, T. FANCSIK, A. Cs. KOVÁCS, R. CSABAFI and
CELEBRATION WORKING GROUP

Introduction

In June 2000 a large consortium of scientific institutions from Europe and North America has completed a huge active source seismic experiment focused on Central Europe. Realizing that the lithospheric structure in the target area is complex, the need for a 3D approach was recognized early in the planning process.

The seismic recordings show good quality data with clear first arrivals up to distances of 150-250 km. The 3D tomographic inversion method of C. Zelt was used to determine the seismic P-wave velocity distribution in the crust using first arrivals only.

The regional 2D tomographic models presented show anomalies that delineate contacts of major tectonic units and reveal possible deep sedimentary bodies. The net of interlocking profiles provided substantial 3D coverage over a 100 km by 150 km area in N-Hungary. The 3D tomographic model highlighted velocity anomalies correlating significant geological features, like a volcanic paleocaldera of Badenian age in the Matra Mountains or deep-seated structures within the Pannonian pre-Tertiary basement.

The importance of the results are that previously unknown structures were detected beneath the thick Cenozoic volcano-sedimentary cover.

Acquisition

The field work for this ambitious project was completed during June of 2000 was led by an experiment team from the geophysical and geological communities in Poland, Hungary, the Slovak Republic, the Czech Republic, Austria, Denmark, Canada, Turkey and the USA, with important contributions from Germany, Finland, Belarus and Russia. The field work involved 3 deployments, about 160.000 seismic records were obtained. The layout was a network of interlocking profiles whose length was 8900 km, the station spacing was 1.4 or 2.8 or 5.6 km. 147 shots were fired along most of the profiles, with the average charge being 500 kg TNT. About 15% of the stations were occupied by 3 component recorders. The 3D model that will ultimately be produced from these data should provide an intriguing image of the deep structure of Central Europe.

Transmission tomography

The location maps on Figure 2. show the actual CEL profiles and shotpoints (dots) involved in the 3D investigations. The total number of raypaths was 2600, for tomographic modeling 1800 picks of P-wave first arrivals were utilized by 3D inversion method of C. Zelt (1998). The initial velocity model was calculated from the available basement depth and overburden velocity data.

The model was established along equidistant nodes in three dimensions, with a cell size of 0.5 km. The size of the model was 441 by 321 by 101 nodes, consisting of more than 14 million cells. The iterations were carried out in three steps with 10 x 10 x 5 km, 5 by 5 by km and 2 by 2 by 1 km steps.

Results and conclusions

Two depth slices of P-wave tomography results are shown in the adjacent figures (Figure 2.). The highlighted velocity anomalies correlate with significant geological features:

On the 3 km depth slice, the highlighted area to the southwest includes the Matra Mountains that are volcanic origin. A mid-Miocene caldera coincides with the velocity anomaly marked by light green and yellow colors (6.5-6.7 km/sec). Significant amounts of Paleogene/Neogene sediments are buried beneath this mountain range, this anomaly is probably due to the batholithic source for the volcanic material.

On the 8 km depth slice, the highlighted area falls in the region of the Zemplén Mountains. The axis of the prominent velocity anomaly has NNW-SSE direction, apparently in contradiction with the typical WSW-ESE direction typical for the Pannonian pre-Neogene basement. The high-pass filtered Bouguer anomaly map of this area exhibits the same strike. A chain of structurally-controlled Cenozoic intrusions could be causing this feature. Another possibility is a deep-seated structure in the basement (Inner Western Carpathian complex of Paleozoic and Mesozoic age). In either case, an interesting and previously unknown structure is required.

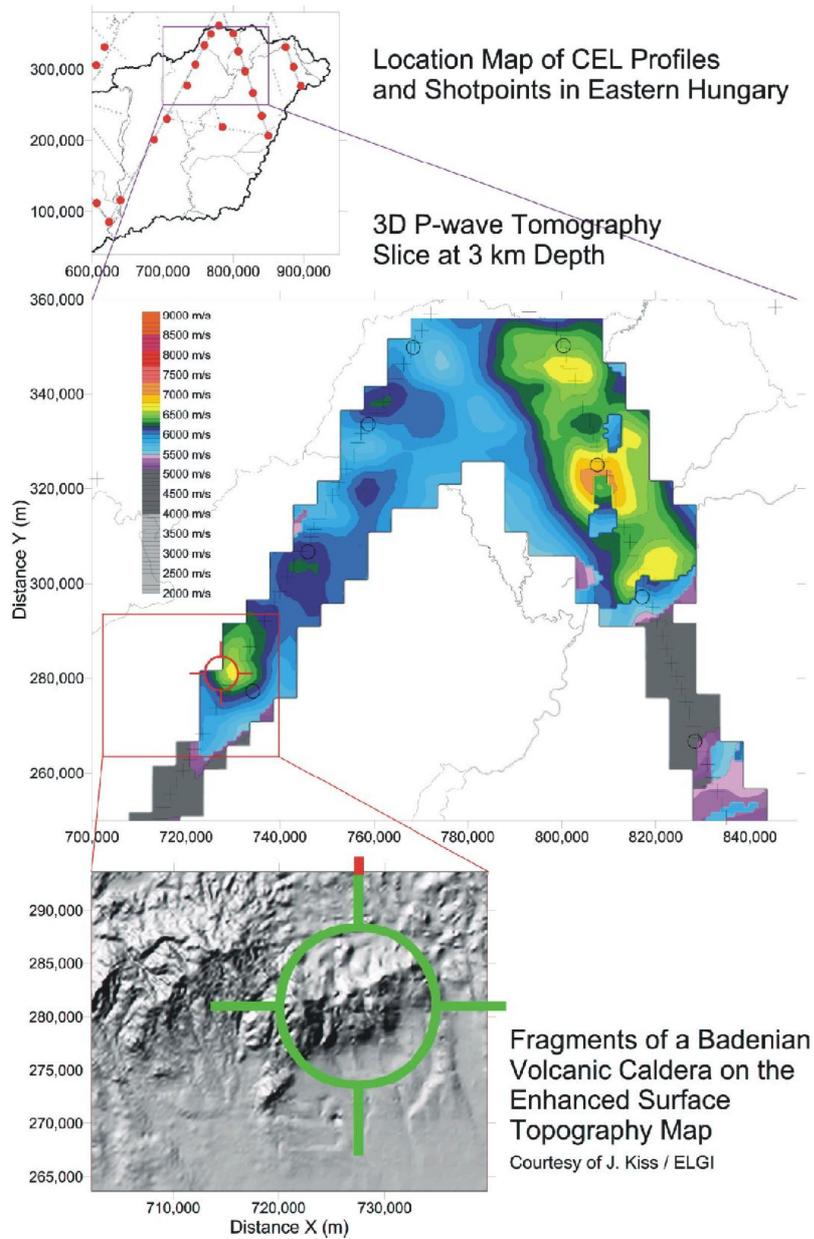
Acknowledgements

The Hungarian part of the acquisition project was funded by MOL Hungarian Oil and Gas Co.

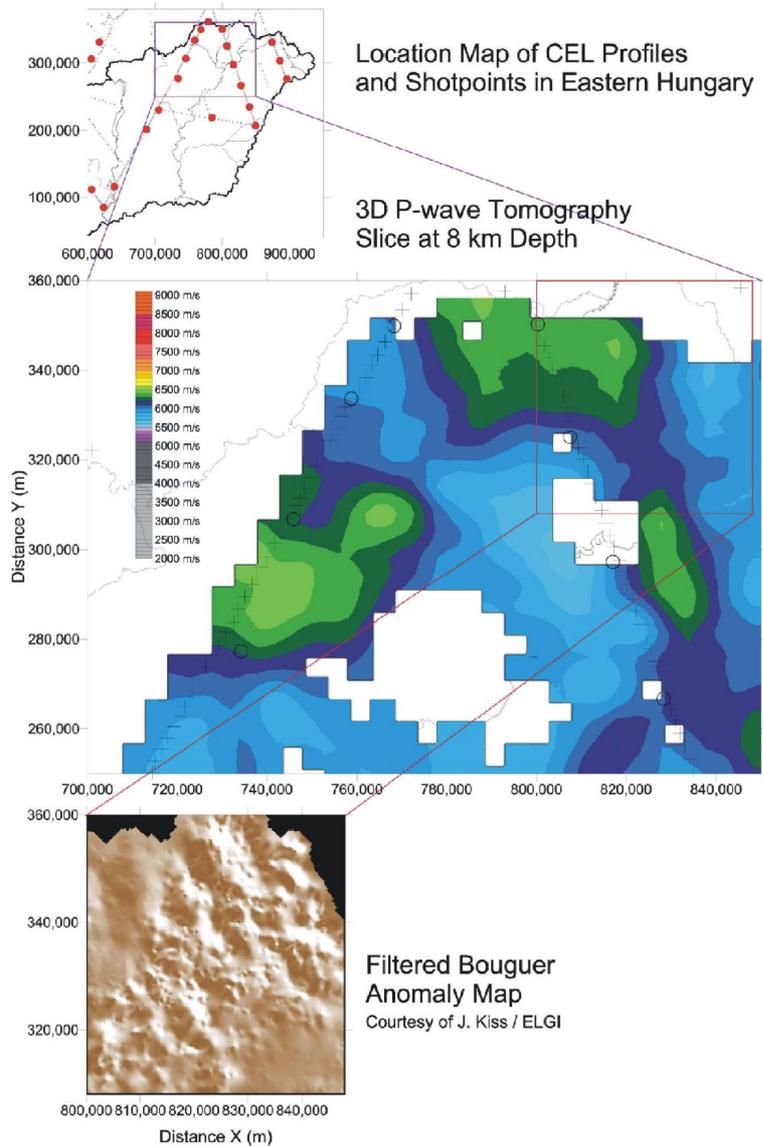
The forward modeling and the inversion was executed on a SUN Enterprise Server 10.000 National Information Infrastructure Development Program in Hungary.

References

- CELEBRATION Organizing Committee and Experiment Team,
Guterch, A., Grad, M. & G. R. Keller 2001: Seismologists Celebrate the New Millennium with an Experiment in Central Europe, EOS Vol. 82, No.45, pp 529-535.
- Posgay, K., Pápa, A., Fancsik, T., Bodoky, T., Hegedűs, E., Takács, E. 2001: Metamorphic and rheologic effects shown by seismic data in the Carpathian Basin, Acta Geologica Hungarica Vol. 44, Number 2-3, pp 113-134.



On the 3 km depth slice, the highlighted area to the southwest includes the Matra Mountains that are volcanic origin. A mid-Miocene paleocaldera coincides with the velocity anomaly marked by light green and yellow colors (6.5-6.7 km/sec). Significant amounts of Paleogene/Neogene sediments are buried beneath this mountain range.



On the 8 km depth slice, the highlighted area falls in the region of the Zemplen Mountains. The axis of the prominent velocity anomaly has an NNW-SSE direction, apparently in contradiction with the typical WSW-ENE direction typical for the Pannonian pre-Neogene basement. The high-pass filtered Bouguer Anomaly Map of this area exhibits the same strike. A chain of structurally-controlled Cenozoic intrusions could be causing this feature. Another possibility is a deep-seated structure in the basement (Inner Western Carpathian Complex of Paleozoic and Mesozoic age). In either case, and interesting and previously unknown structure is revealed.