Geophysical Research Abstracts, Vol. 9, 05165, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-05165

Southeastern Carpathians nappe architecture and Focsani Basin embodiment from 2D seismic ray-tracing

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The DACIA-PLAN (Danube and Carpathian Integrated Action on Processes in the Lithosphere and Neotectonics) deep reflection seismic profile crosses the southeastern Romanian Carpathians and their foreland in a WNW-ESE direction to near the Danube River. The seismic profile is 140 km long and runs through the southeastern Carpathians nappe stack (Tarcau, Marginal Folds, and Subcarpathian nappes) and the Focsani Basin, including the crustal scale Peceneaga–Camena Fault. A total number of 131 shots with 1 km spacing, were detonated from which 127 were successfully recorded on three deployments of up to 640 autonomous one-component digital seismographs.

First arrival seismic 2D ray-tracing of these data was carried out using RayInvr The number of shots used in the forward modelling was initially set to 10 but it increased during the ray-tracing process to a total final number of 43 (every third shot was chosen - where the signal to noise ratio was poor, an adjacent shot gather was analyzed). Of the 22194 traces recorded, 11288 were considered clear enough (pick uncertainty $<$ 50 ms) to be used in the forward modelling.

The main steps adopted in the ray-tracing approach included: a) incorporating first and later phases (usually difficult to pick) into the model, b) assigning layers inferred from velocity and traveltime studies, c) selecting specific model parameterizations, d) obtaining a preliminary (seismological) model, and d) incorporating known structural features (from geological, tectonic and geophysical studies) not specifically required by the data into the preliminary model. These steps and the continuum play between preliminary and final velocity model strengthened the model constraints and dimin-

ished its non-uniqueness.

The velocity structure of the 2D ray-tracing model extends to a depth of about 20 km along the seismic profile. Depth to basement, as well as lateral structural heterogeneity at the basement level, beneath the Focsani Basin resolved by the model, is highly correlatable with structure and phenomena associated with the structure of this area inferred from other, independent geological and geophysical data. Anomalously shallow high velocities located at 3-3.5 km depths strongly indicate that pre-Tertiary basement in the Vrancea Zone is shallower than previously deduced in published geological cross-sections and recent 3D velocity models derived from refraction data. Complexities in this part of the seismic profile observed in the travel-time data suggest that basement material (characterised by velocities greater than 5.8 km/s) is involved in Carpathian thrusting. Further to the east, at the foreland basin-thrust belt transition zone (well defined within velocity values), the velocity model suggests a nose of the Miocene Subcarpathians nappe being underlain by Focsani Basin units. A Miocene and younger Focsani Basin sedimentary succession of $\sim$12 km thickness is ascertained by a gradual increase of velocities and strongly defined velocity boundaries.