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# The crustal structure beneath SE Romania from teleseismic receiver functions

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## SUMMARY

Due to vigorous Neogene geodynamic processes, including oceanic subduction, slab break-off and mountain building in the Carpathian Arc, the architecture of the lithosphere in Romania is quite complicated. To improve the knowledge about the lithosphere–asthenosphere system in this region the passive seismological CALIXTO99 experiment was conducted in 1999 in the SE part of Romania. Here we present crustal models derived from the analysis of teleseismic recordings with the receiver function (RF) method of the 120 temporarily installed stations and of the permanent GEOFON stations MLR and TIRR. The RF results extend the known crustal models which are based mainly on seismic refraction work and analysis of regional earthquakes. We apply a grid-search inversion at 30 stations and use two different error estimation methods to determine the Moho depth and the average crustal $v_p/v_s$ ratio. The complex 3-D intracrustal structure, especially the deep sedimentary basins, distorts significantly the RF waveforms within the whole station network. This leads to ambiguous results at some stations. Our model of the Moho depth has a maximum crustal thickness in the SE Carpathian Mountains at station MLR with a depth of about 45 km and an average crustal $v_p/v_s$ ratio of 1.79. The surrounding crust in SE Romania has a thickness of mainly 35–40 km. The RFs at MLR are characterized by clear azimuthal effects that can be correlated with the variation of the sediment thickness in the foredeep of the Carpathian Mountains. A RF waveform inversion verifies these results and gains improved 1-D *S*-wave velocity models at several stations in SE Romania.

**Key words:** crustal structure, Moho, receiver functions, Romania.



## 1 INTRODUCTION

The intensive study of the Eastern and Southern Carpathian Mountains and their intermediate-depth seismicity started after the disastrous earthquake in 1977 (Fuchs *et al.* 1979) when 1570 people died mainly in Bucharest, the capital of Romania. Since then numerous questions appeared about the cause for these strong earthquakes and the consequences for SE Romania (e.g. Wenzel *et al.* 1998, 1999). The seismicity of the region (Fig. 1) can be divided in two different types, namely the widely scattered shallow crustal seismic activity with moderate magnitudes (up to $M \sim 6$) and the intense intermediate-depth seismicity (up at least $M = 7.7$), which is concentrated in a very small area of about 40 km × 80 km and a depth range between 60 and 180 km (Oncescu & Bonjer 1997; Oncescu *et al.* 1999). In this area, called the Vrancea source zone (Fig. 1), the moment magnitudes can reach at least $M_w \sim 7.7$ (e.g. in 1940 November). These earthquakes represent a major potential hazard for the whole region, especially for the metropolitan area of Bucharest that is built on relatively unconsolidated sediments. The intermediate-depth seismicity (Fig. 1, inset) is separated from the crustal events by a transition zone with only weak seismicity between about 40 and 60 km depth (Fuchs *et al.* 1979; Oncescu *et al.* 1999).

Several tomography studies revealed an isolated body with high seismic velocity in the upper mantle underneath the Vrancea region (e.g. Oncescu *et al.* 1984; Fan *et al.* 1998; Wortel & Spakman 2000). This anomaly is interpreted as subducted and detached oceanic lithosphere (Wenzel *et al.* 1998; Sperner *et al.* 2001). The subduction-related stresses have been identified as the source of the intermediate-depth seismicity. Nevertheless, there are still a lot of uncertainties concerning, for example, the coupling between crust and slab as well as the spatial dimension of the sinking slab.

For a better understanding of the Vrancea earthquakes detailed investigations of the crustal and uppermost mantle structures are conducted within the framework of the Collaborating Research Centre 461 'Strong Earthquakes—a Challenge for Geosciences and Civil Engineering' at the University of Karlsruhe (Germany) in close cooperation with the Romanian Group for Vrancea Strong Earthquakes at the Romanian Academy in Bucharest (Wenzel *et al.* 1998). In 1999, the VRANCEA99 seismic refraction project was conducted, in order to study the crust (Hauser *et al.* 2001;

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