

E Conclusions and open questions

The detailed mapping of the crust-mantle boundary in the western Eger Rift was done using Ps receiver functions with a higher lateral resolution than it is possible by refraction seismic studies. The lithospheric structural features observed in this study are of local dimension. Only due to a dense spacing of seismic stations and sufficiently long recording times of medium- to broadband stations it was possible to resolve them. Crustal and Moho arrivals could also be observed studying the data from the permanent triggered short-period networks in NW-Bohemia, but it was not possible to invert these data for Moho depth and v_p/v_s ratios due to missing crustal multiples.

The cause of some low average crustal v_p/v_s ratios (1.63 to 1.67) in the study area remains unsolved. The interpretation of v_p/v_s ratios needs further effort, the application of laboratory measurements to in-situ conditions, especially.

Using teleseismic receiver functions a local "6 s phases" was detected underneath the area of CO₂ emanations and Quaternary volcanism, which could be interpreted as caused by a converter at about 50 to 60 km depth and/or a low velocity zone in the middle crust. Previously, a reflector was detected by reflection seismic studies at 55 km depth [Tomek *et al.*, 1997]. New wide-angle seismic data also show a local reflector at this depth range [Hrubcova, personal communication]. More seismic data, detailed analysis, as well as more petro- and mineral-physical data are needed to clarify the extend and the nature of this probable local seismic upper mantle discontinuity.

New, more detailed results can be obtained from running active and passive seismic investigations in the area. The huge data set of the BOHEMA project 2000-2003 (including receiver function, tomography and anisotropy studies) is already under investigation [Babuška *et al.*, 2003]. Further detailed velocity information at least for the crust can be expected from wide-angle seismic experiments, which were carried out recently, namely CELEBRATION-2000 and SUDETES-2003 [Guterch *et al.*, 2003]. A synopsis of the results from passive seismic investigations, wide-angle seismic experiments, and the re-processing of the deep-seismic profile 9HR would be very useful to improve the location and identification of velocity contrasts of the seismic discontinuities.

The existence of a mantle finger like proposed under the French Massif Central and the Eifel, Germany, could not be proved or denied in this study. However, the apparent deepening of the '410' beneath the study area might indicate for the presence of lower seismic velocities in the upper mantle than in the IASP91 reference model.

The xenolith study showed that most of the analysed samples are cumulates of alkaline melts or fragments of a metasomatic upper mantle; no orthopyroxene-bearing spinel-lherzolitic xenoliths were found in the Quaternary volcanics up to now. Geothermobarometric estimates for most samples indicate a depth of origin of about 25 to 40 km. This depth range might be the intrusion level for the

alkaline melts in the past and also presently, since there are still exhalations of gases with upper mantle isotope signatures (C, He, N) at the surface in the area under study [Bräuer *et al.*, 2004].

Calculated equilibrium or crystallization temperatures are higher than indicated by the extrapolation of regional geotherms derived from surface heat flow studies. Hornblendite and clinopyroxenite samples could be fragments of small magmatic intrusions into the uppermost mantle and lower crust (dikes and sills), which could cause local scale thermal and magmatic overprinting of the Moho as, indicated by the receiver function study. However, the studied xenolith suite and available p-T data from the broader region do not allow making better constraints (xenolith geotherm) on the overall thermal structure in the lower crust and uppermost mantle so far. Further studies on xenoliths from Tertiary and Quaternary volcanics (including p-T, isotope, and fluid/melt inclusion studies) are necessary for the construction of a regional xenolith geotherm and the understanding of the Tertiary to Quaternary evolution of the upper mantle and lower crust.

There are a lot of further questions related to the possible existence of and processes related to a covered deep-seated magmatic activity beneath the swarm-earthquake region and CO₂ degassing field. There is a massive need for the identification of seismic reflections/conversion related to fluids in the lower crust and uppermost mantle in the existing and new seismic data. Further fluid inclusion studies could help to identify the depth level of separation of CO₂ from melts. The question if the alkaline melts play a direct role in the hypocentres of swarm-earthquakes as supposed by Špičák *et al.* [1999] can possibly be solved by improved seismological and noble gas isotope observations or as a final stage deep drilling. Very interesting would be the study of seismicity related to possible fluid movements in the middle and lower crust. Maybe a new sensitive seismic network with still better signal-to-noise ratio than the existing ones (seismometers in boreholes?) can shed some light on deep low-magnitude seismicity. Assuming that magmatic activity has been going on since the Tertiary but at least since 0.3 to 0.5 Ma, there should be a thermal signal somewhere in the crust. To find signals of this probable thermal perturbation heat flow studies in one or more deep boreholes are necessary.

In this work, a first compilation of seismic, petrological [*this study*], seismological, and gas-geochemical results [*from literature*] was done, which might point to a local scale active magmatic addition to the base of the continental crust in a rift environment. CO₂-rich gases (fluids) rising from melts at the crust-mantle boundary to the Earth's surface influence the seismicity of the upper crust. The combination of these different geoscientific methods has a high potential for the detection and evaluation of deep covered magmatic/fluid activity within continental rift areas. The observations should be confirmed by additional measurements in Vogtland/NW-Bohemia as well as in other volcanic fields of Western and Central Europe (e.g., the French Massif Central, the Eifel, and the Jeseníky volcanic fields).