P Receiver Function Analysis in the Pannonian Basin

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MOMENTUM OF INNOVATION

Study area and seismic stations

Our study area is the Eastern Alps-Carpathian-Pannonian Basin region, where a dense seismological network allows a detailed analysis of the crust mantle boundary. The Pannonian Basin is a geologically complex extensional back-arc basin in Central Europe (Fig. 1.). The Moho discontinuity is generally at shallow depth (20-35 km) in the Pannonian basin as a result of a Miocene extensional event (Horváth et al. 2006). However, the Eastern Alps and Carpathians are characterised by deeper Moho (35-45 km) and a more complex lithospheric structure. In recent years the permanent networks became denser and several temporary deployment campaigns, such as the Carpathian Basin Project (CBP), the South Carpathian Project (SCP) and the AlpArray experiment (Hetényi et al. 2018a) took place. Thus, we used the data of 221 seismological stations for the receiver function analysis.

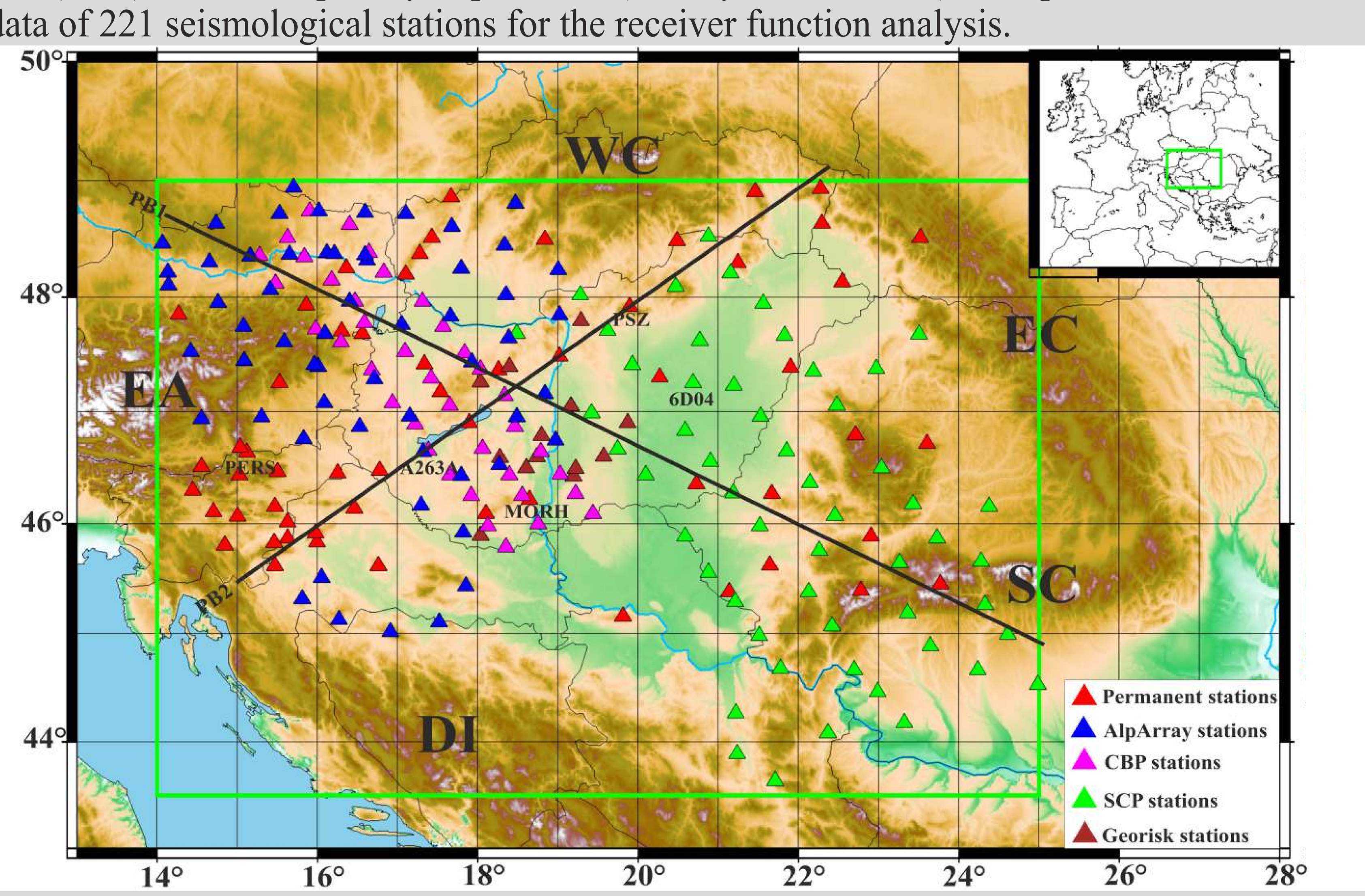
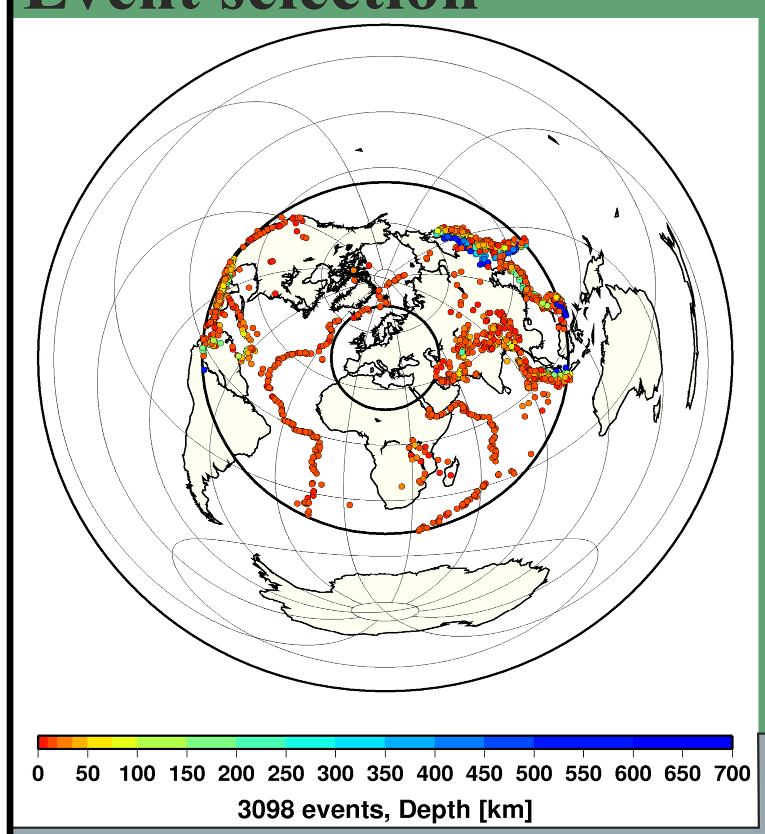


Figure 1. Investigated area, the seismic stations used in this study. Colours triangles shows different type of seismological stations. PB1 and PB2 mark the locations of migrated cross-sections. Abbreviations: DI-Dinarides; EA- Eastern Alps; EC- Eastern Carpathians; SC- Southern Carpathians; WC - Western Carpathians.

Event selection



- teleseismic earthquakes
- 28°-95° epicentral distances
- magnitudes larger than 5.5
- broadband three-component waveforms filtered them between 0.1 and 1 Hz for the H-K and CCP migration; 0.1 and 0.5 for the inversion
- 3 year 3 months of data from the AlpArray temporary network
- 2 years data from CBP and SCP stations
- for the Hungarian and other permanent stations we used all available data since they entered into operations up until March 31 2019

Figure 2. Location of the 3098 earthquakes used in the receiver function analysis.

Quality control

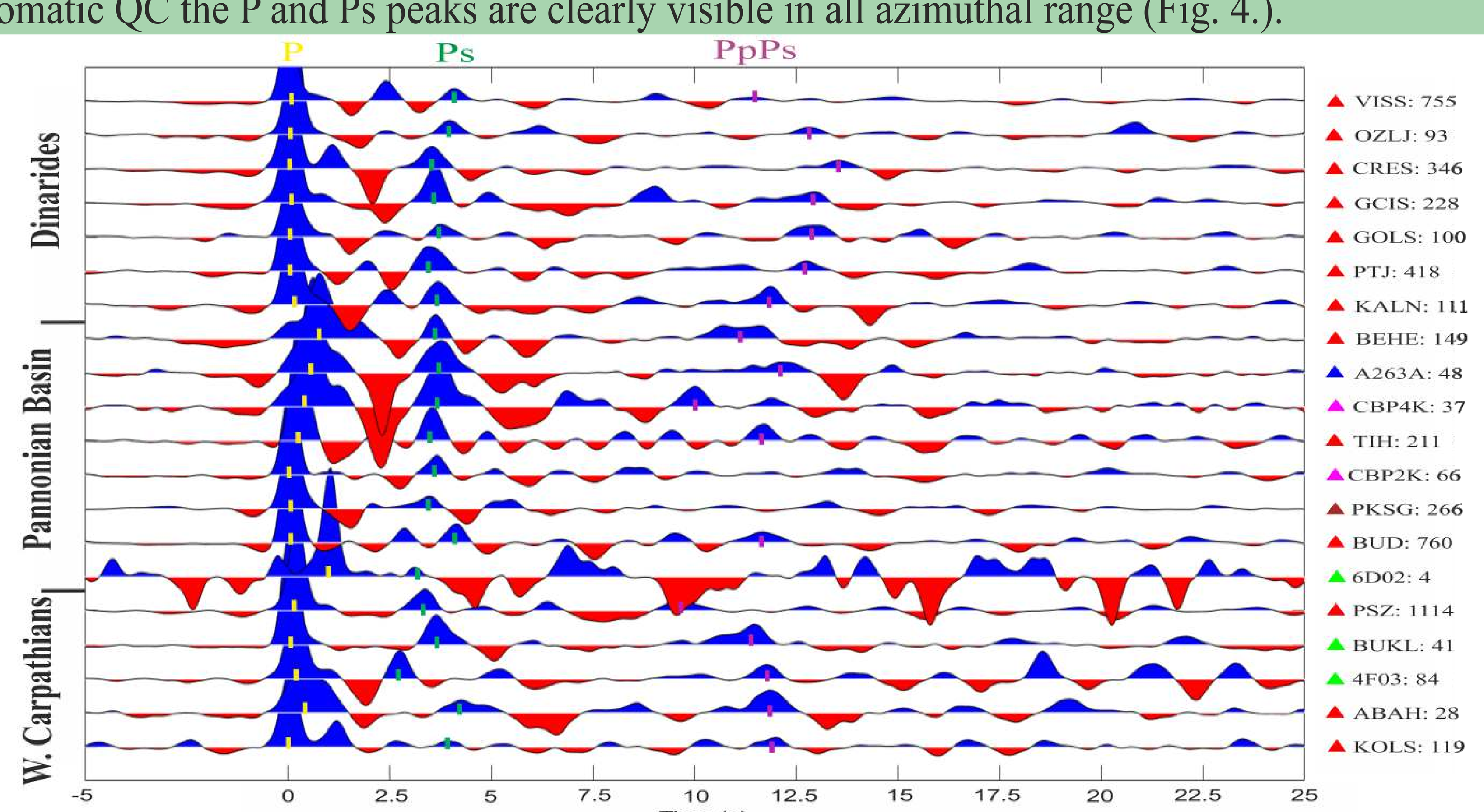
We applied three quality control methods. The first (QC1) was an STA/LTA detector with detection threshold 3.5. The second (QC2) was performed in time window 30 s before and 90 s after the first-arriving P-wave. Waveforms with a signal-to-noise ratio above threshold were accepted (Hetényi et al. 2018b).The last quality control method (QC3) was performed on calculated receiver functions. Receiver functions were rejected as poor quality if the P peak below threshold.

Downloaded waveforms	After QC1	After QC2	After QC3
454.089	240.828	171.255	31.260

Table 1. Number of waveforms after downloading, QC1, QC2 and QC3 at all dataset.

Receiver function analysis

For the receiver function analysis we used the iterative time domain deconvolution (Lígorria and Ammon, 1999) with 150 iterations. P, Ps and PpPs multiples are clearly visible in the Dinarides and Western Carpathian, but we can identify only P and Ps peaks in the Pannonian Basin in PB2 section (Fig. 3.). We present the radial and transversal receiver functions at PSZ station. Owing to the automatic QC the P and Ps peaks are clearly visible in all azimuthal range (Fig. 4.).



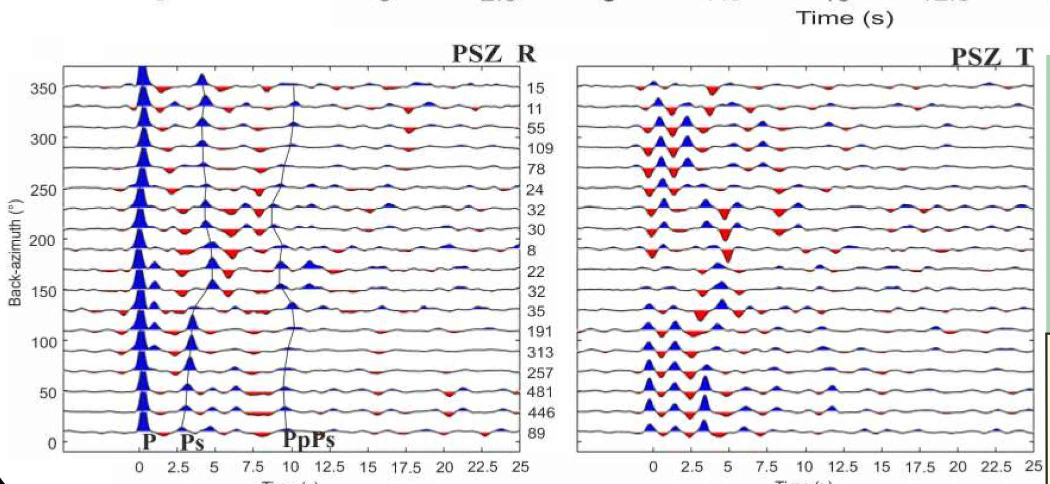


Figure 3. Stacked receiver functions at stations along the PB2 profile.
Figure 4. Radial and transversal receiver function at PSZ station, sorted by back-azimuth.

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H-K Grid Search method

We performed the H-K Grid search method Zhu and Kanamori (2000) on the accepted receiver functions.We set different initial Vp velocity for each stations, depending on sedimentary cover. We set the weights of Ps, PpPs and PpSs+ PsPs separately for each station. The Moho is between 20 and 45 km in the investigated area. The average uncertainty of Moho determination is 1.4 km.

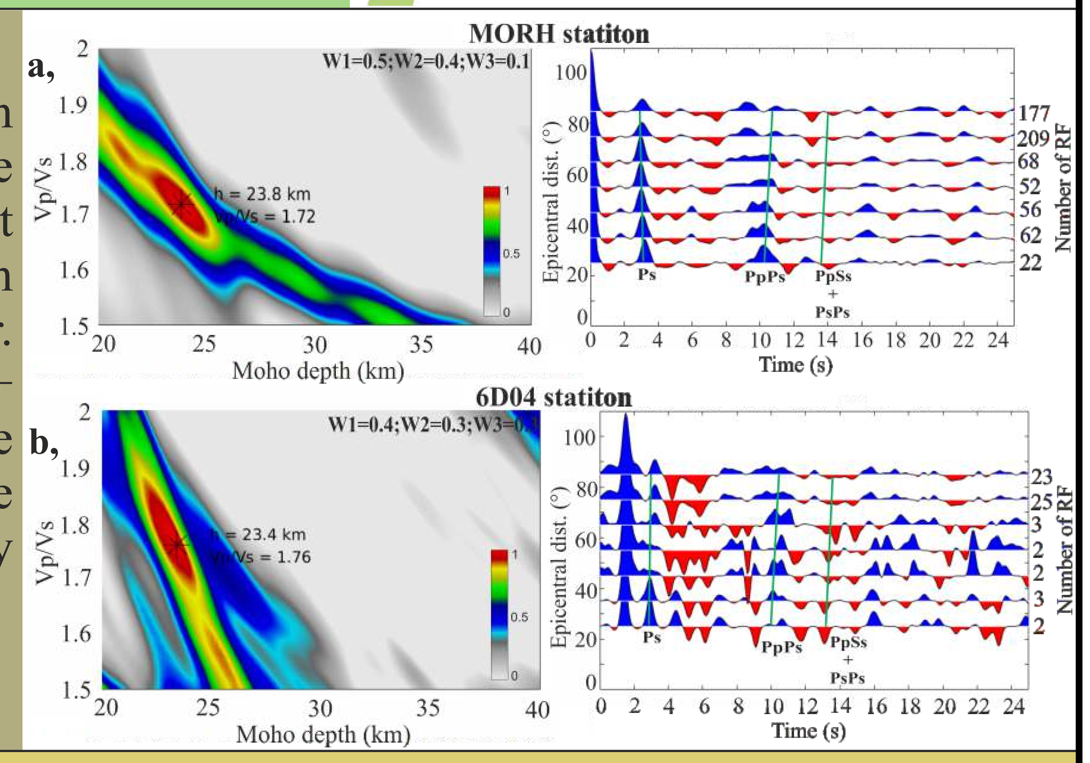


Figure 5. H-K grid search results a, MORH (hard rock); b, 6D04 (sedimentary) station.

6. Migration

We performed common conversion point (CCP) migration to image the Moho depth beneath the Pannonian Basin independently from the H-K analysis. We defined two profiles, the first from the Eastern Alps to the Southern Carpathians (PB1) and the second section from the Dinarides to the Western Carpathians (PB2). We used 1D, Gráczer and Wéber (2012) local velocity modell. Fig. 1. shows the locations of migrated cross-sections.

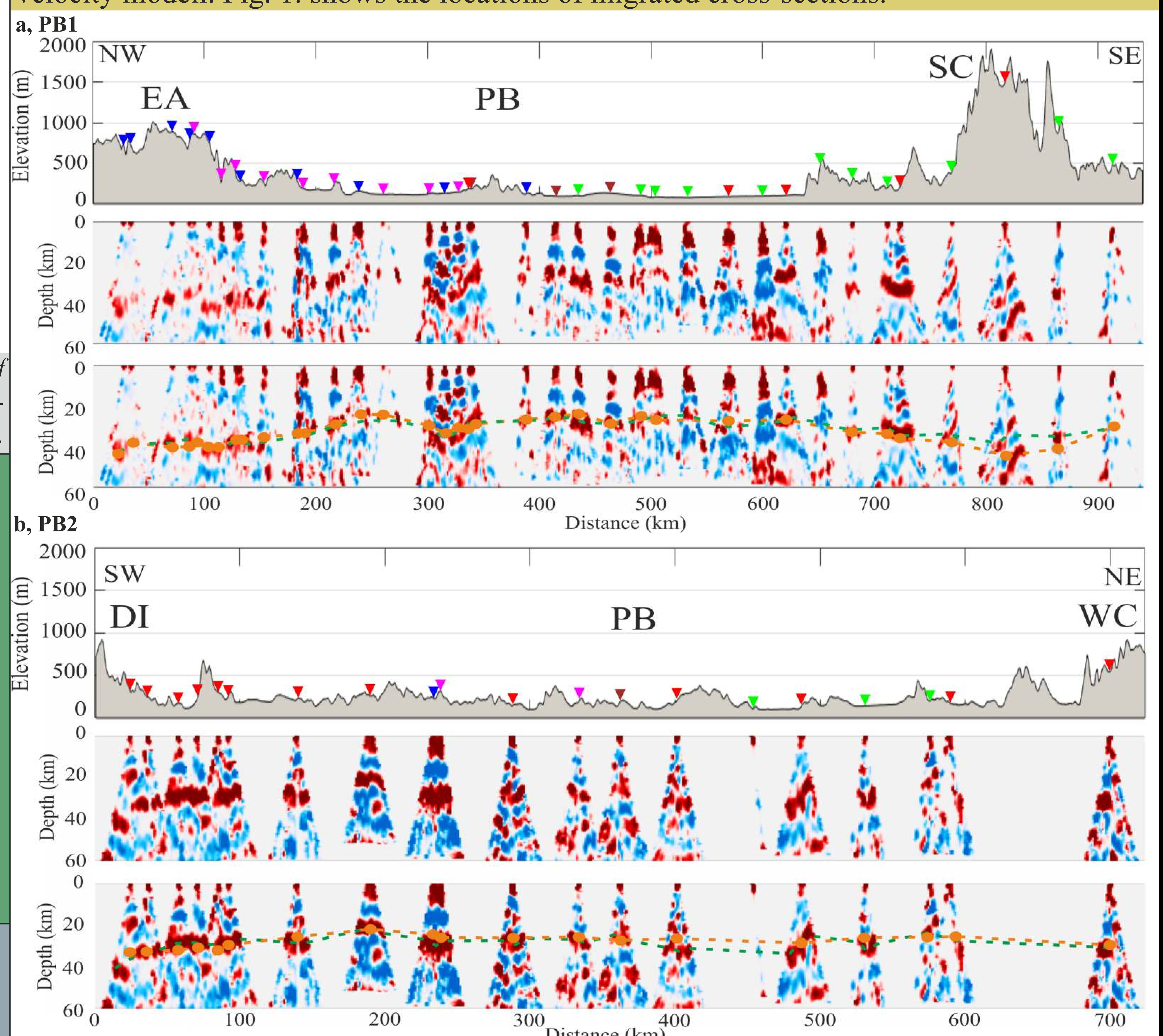
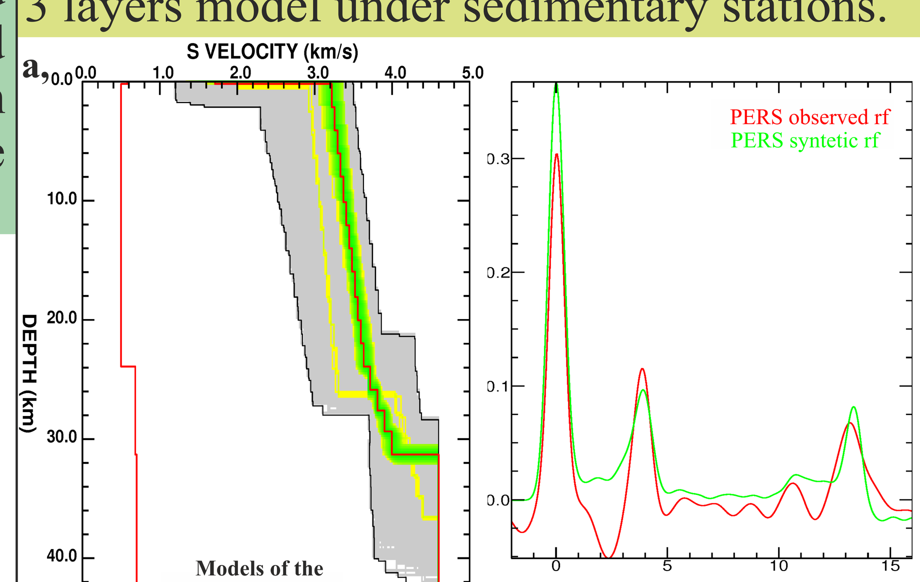


Figure 6. Migrated P-to-S receiver function cross-sections for lines a, PB1 and b, PB2. The dotted green lines present the Moho depth from migration methods. The orange circles show the depth of Moho beneath each station from H-K grid search method. The dotted orange lines show the interpolated depth of Moho from the H-K method.

Inversion

We apply shear-wave velocity inversion methods beneath individual stations based on Sambridge (1999). We tested 2 layers initial model beneath hard rock stations and 3 layers model under sedimentary stations.



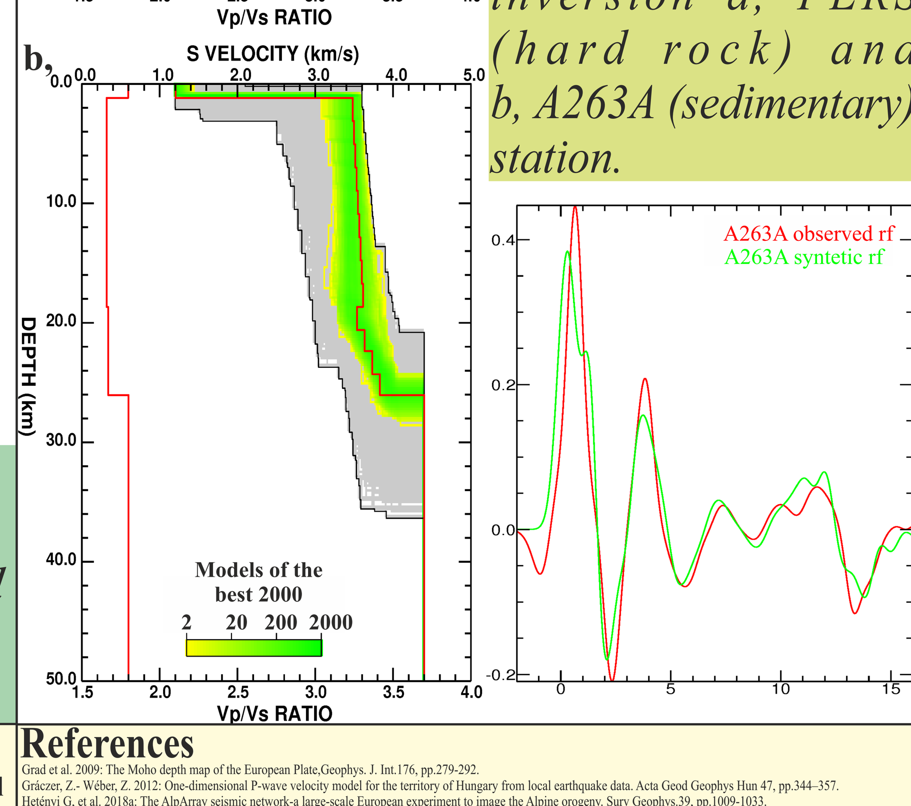


Figure 7. Result of inversion a, PERS (hard rock) and b, A263A (sedimentary) station.

Conclusion: Moho map

We present Moho map from 1D H-K grid search method with triangulate interpolation method, and compare it with that of Grad et al. (2009). We expect to produce a more detailed map in the future.

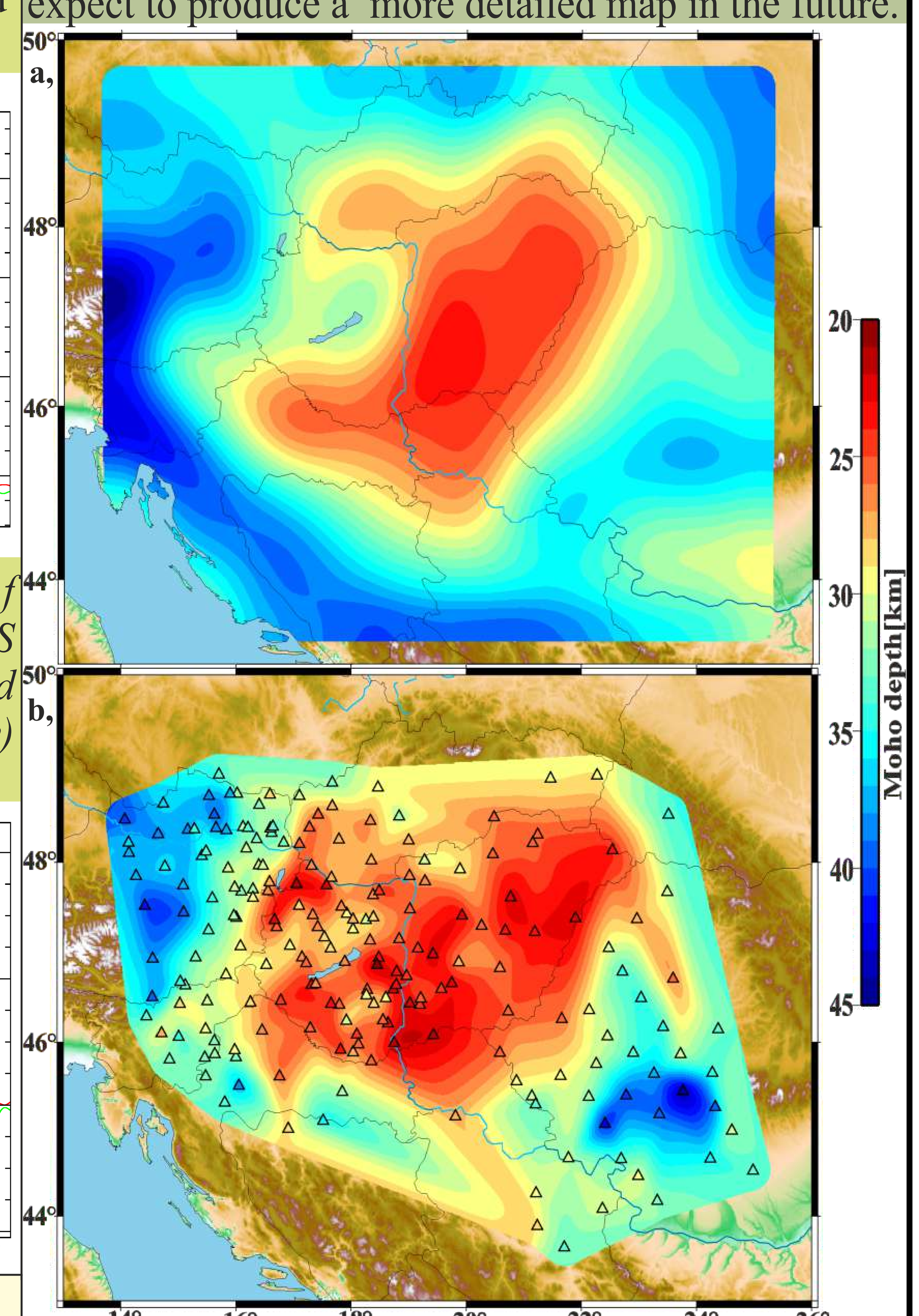


Figure 8. Moho map from a, Grad et al. (2009) and b, this study.

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