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Crust velocity structure beneath two seismic stations on the southern edge of the Central Alborz (Iran)

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Extended Abstract

Summary

Crust velocity structure beneath two broadband seismic stations of Iran National Seismic Network (INSN), DAMV and THKV located in Central Alborz has been investigated by joint inversion of receiver function and Rayleigh wave phase and group velocity dispersion curves. The result suggests that Moho depth beneath the THKV and DAMV stations are 50-51 km and 52-54 km, respectively. Beneath the THKV station, there is a thin layer of very low-velocity materials at the surface and a sedimentary layer having a thickness of 10-12 km above a crystalline crust with a thickness of 34 km. Beneath the DAMV station, there is a thin sedimentary layer of low velocity with a thickness of 3-4 km, and also, a velocity change from 3.2 to 3.6 km/s at the depth of 14-16 km, indicating a discontinuity, which might be attributed to the border between the upper and lower crusts. The average Moho depth on the southern edge of Central Alborz is 52±2 km.

Introduction

The Alborz belt as an active belt extends from Talesh Mountains in the northwest of Iran to Kopehdagh Mountains in northeast of Iran. The capital city, Tehran, with a floating population of over 8 million people, is located in the southern part of the Alborz Mountains range and is surrounded by active faults. As there is a little geological evidence of fault activity in some areas around Tehran, the study of the crust velocity structure in the region plays an important role in better understanding of the geological and geophysical issues. Several studies have been carried out by various researchers to determine the crustal structure beneath the two stations. However, these researchers have stated different thicknesses for the crustal structure beneath these two stations. Sodoudi et al. (2009) have obtained a thickness of 67 km for the crust beneath the DAMV station. In this regard, we have tried to study the crustal structure again using more data than those used in previous studies, and also, using newer phase and group velocity dispersion curves, given by Rahimi et al. (2014), to ensure the validity of the results of previous studies about the Moho depth and the crust thickness. As a result, this study can confirm or modify the results of previous studies.

Methodology and Approaches

To determine the receiver functions, time-domain iterative deconvolution of Ligorria and Ammon (1999) and teleseismic events from 2009 to 2013 with magnitudes more than 5.0 were used. After correcting the data for instrument effects (gain and instrument response) and rotating the horizontal components to radial and tangential directions, in order to reduce high-frequency noise, a Gaussian filter with width parameter equal to 1 was applied to seismograms. To strengthen phase amplitudes and enhance the noise-to-signal ratio (S/N), the receiver functions of the events close to each other, were sorted and stacked up. The fundamental mode Rayleigh wave group and phase velocities dispersion curves, provided by Rahimi et al. (2014) on the structure of crust and upper mantle of the Iranian Plateau for the period interval of 10-100 sec, were used. The depth-velocity trade-off in the receiver functions caused non-uniqueness in the inverse problem. Using joint inversion of two datasets, this shortcoming could be compromised. The joint inversion was performed by the computer program in the seismology package presented by Herrmann and Ammon (2003).

Results and Conclusions

For all back azimuthal ranges of the two stations, we have made the joint inversion of phase and group velocity dispersion curves and receiver functions. As a result, we have obtained the Moho depth beneath the THKV and DAMV stations equal to 50-51 km and 52-54 km, respectively. Beneath the THKV station, we have also found the existence of a thin layer comprising of a very low-velocity materials (Vs<2.7 km/s) at the surface and a sedimentary layer, having a thickness of 10-12 km and an average shear velocity of 2.8 km/s, above a crystalline crust with a thickness of 34 km and an average shear wave velocity of 3.6 km/s. Beneath the DAMV station, a thin sedimentary layer of low velocity with a thickness of 3-4 km with a thickness of 3-4 km has been observed, Moreover, a velocity change from 3.2 to 3.6 km/s at the depth of 14-16 kilometers indicates a discontinuity which might be attributed to the border between the upper and lower crusts, i.e. the Conrad discontinuity. A clear velocity change from 3.6 to 4.2 km/s at the depth of 52-54±2 can be attributed to the Moho boundary. The average thickness of the crystalline crust is estimated to be 51 km. In the model obtained by Abbassi et al. (2010) with the same method (but using different data), the transition zone from the crust to the mantle is observed in the depth range of 55- 58 km with a velocity change of 3.8-4.2 km/s, while in the model obtained from the present study, the Moho depth is found to be at a depth of 52-54 km with a velocity change of 3.6-4.2 km/s. Considering to the error range in the joint inversion method, the results of these two studies are almost close to each other. Sodoudi et al. (2009) have also obtained the crustal thickness of 67 kilometers beneath the DAMV station by using receiver function method. They have attributed this high thickness to the accumulation of magma in this volcanic area. At the THKV station, we have compared the models obtained from the current study with the results of the study carried out by Javan and Roberts (2003) and AK135. Consequently, it is found out that the position of the velocity discontinuities in the upper parts of the crust (at the depth of 14 km) is almost the same in all the three models, but the position of the Moho in the model obtained from this study, compared to the other two models, is observed to be deeper. In this regard, Javan and Roberts (2003) have found the Moho discontinuity depth of 46 km, while in this study, the Moho discontinuity at the depth of 51-50 km has been obtained.
