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Crustal velocity structure and Moho discontinuity depth in northeast of Iran

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Extended Abstract

Summary

Crustal velocity structure beneath four broadband seismic stations located in northeast of Iran, including Shahrood (SHRO) and Maraveh Tappeh (MRVT) stations set up by Iran National Seismic Network (INSN) and Sabzevar (SZBV) and Jarkhoshk (JRKH) stations set up by Iranian Seismology Center (IRSC), have been investigated by joint inversion of P receiver function and Rayleigh wave phase and group velocity dispersion curves. A three-year teleseismic data (2012 -2014) with epicentral distance of 25°-90° and magnitude more than 5.5 have been used to determine the receiver functions by iterative deconvolution in time domain proposed by Ligorria and Ammon (1999). Iterative deconvolution in time domain to determine the receiver functions are more stable with noisy data in comparison to frequency domain. The fundamental mode of Rayleigh wave group and phase velocity dispersion curves have been provided by the study on the structure of crust and upper mantle of the Iranian Plateau for the period interval of 10-100 seconds made by Rahimi (2010).

A combined inversion of body wave receiver functions and Rayleigh wave velocities increases the uniqueness of the solution over the separate inversions, and also, facilitates explicit parameterization of the layer thickness in the model space.

Moho discontinuity depth is one of the most important parameters for investigation of crustal structure. The results of this study indicate an average crustal thickness varying from 38 km beneath Maraveh Tappeh (MRVT) station in north of the study region up to 44 km beneath Shahrood (SHRO) station in west of the region. Moreover, the results of this study suggest that the average crust thickness beneath Sabzevar (SZBV) and Jarkhoshk (JRKH) stations located in center and east of the study region is 40 km.

In general, northeastern Iran region has a thin crust compared to the crusts in the other areas investigated in this research work. It has also been shown that the joint inversion method can cause ±2 kilometers of error.

Introduction

Iran is situated in one of the world's seismic regions and the possibility of destructive earthquakes in most regions of the country has given great significance to recognition of Iranian seismic nature from a seismic and seismotectonic standpoint. The seismicity within Iran suggests that much of the deformation is concentrated in the Zagros, Alborz and Koppeh Dagh mountains, and in east of Iran, surrounding Central Iran and the Lut desert. The aim of this research is to study the crustal structure and Moho discontinuity of northeastern Iran region, Binalood mountains and Koppeh Dagh by the analysis of receiver function and surface waves dispersion.

Methodology and Approaches

Receivers functions are time series obtained from three-component seismometers, and are created by deconvolving the vertical component from the radial and transverse components of the seismogram to isolate the receiver site effects from the other information contained in a teleseismic P and S wave.

The depth-velocity trade-off in receiver function causes nonuniqueness in the inverse problem. However, by incorporating information of absolute shear wave from dispersion estimates and joint inversion of these two datasets, this shortcoming can be compromised. To determine the receiver functions, we have used iterative deconvolution in time domain, proposed by Ligorria and Ammon (1999) that is more stable with noisy data in comparison to frequency domain. We have processed teleseismic events with epicentral distance of 25°-90° and magnitudes more than 5.5 that are recorded at a three-year time interval of 2012 to 2014. We have set the parameter *a* of the Gaussian filter to 1.00,

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which gives an effective high frequency limit of about 0.5 in the P wave. In order to eliminate the source, path and instrument effects, deconvolution of the vertical component from the horizontal components of the seismograms has been used. All receiver functions have been grouped by azimuth (<10◦) and distance (<15◦), and in order to improve the signal-to-noise ratio, the individual receiver functions within each group have been stacked.
The fundamental mode of the Rayleigh wave group and phase velocities dispersion curves have been provided from the study carried out by Rahimi et al., (2014) on the structure of crust and upper mantle of the Iranian Plateau for the period interval of 10-100 seconds. Joint inversion of two independent data sets has been performed by considering appropriate weighting parameter obtained from Herrmann and Ammon program (2003). Minimizing standard error between real and predicted data is the criteria for getting the desired final and close to the earth real model. The inversion package requires that the real velocity structure is represented by a set of flat-lying, homogeneous, isotropic velocity layers. The starting model comprises of the layers having 1-km thick as the top 6 km of the model space, 2-km thick between the depths of 6 and 66 km, and 4 km thick between the depths of 66 and 78 km. The starting velocity for each layer in the model has been Vp=8.0 km/s, which equates to upper mantle velocity.

Results and Conclusions

The results of this study suggest that the average crust thickness beneath Shahrood (SHRO) station, located in west of the study region is 44 km and the average crust thickness beneath Sabzevar (SZBV) and Jarkhoshk (JRKH) stations located in center and east of the study region is 40 km. Furthermore, the crust thickness beneath Maraveh Tappeh (MRVT) station located in north of Koppeh Dagh region in is 38 km. In general, northeastern Iran region has a thin crust compared to the crust in other areas of northeast of Iran.

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