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The effect of temperature anomalies on the thickness of upper mantle transition zone in northwest of Zagros using teleseismic waves

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Extended Abstract

Summary

We have computed P receiver functions to investigate the upper mantle discontinuity beneath northewest of Zagros in Iran. We have selected data from teleseismic events ($M_b \geq 5.5$, $30^{\circ} < \triangle < 95^{\circ}$) that have been recorded since 2004 to 2016 at three-component short period and broadband stations from Kermanshah and Khoramabad telemetry seismic network and three-component broadband stations in Sanandaj area. The P to S converted phases from 410 and 660 km discontinuities are observed. The results show that the thickness of the upper mantle transition zone in the study area is not the same as that in the entire region, and it is shown a little deviation rather than IASP91 model and appears to be depressed under the Urumieh-Dokhtar zone having northwest-southeast direction. The maximum temperature anomaly is equal to 180˚C and 450˚C for 410 and 660 km discontinuities, respectively.

Introduction

Today, the energy supply is a significant problem in human life. Iran is one of the countries on the global seismic belt to study geothermal energy. Renewable Energy Organization of Iran, called SUNA, reported in 1998 that northwest of Zagros is a suitable area for geothermal energy, which has led to a better understanding of tectonic processing the structure of upper mantle in the study area via seismic methods of P receiver function. The equilibrium depths of 410 and 660 km seismic discontinuities depend on the ambient mantle temperature and pressure conditions, described by the Clayperon slope. Converting the pressure change to the depth, the vertical displacement is calculated. The time difference between the P-to-S conversions of the two discontinuities is independent of the shallow mantle structure, and therefore, indicates the thickness of the transition zone. By comparing this differential time with the global average value (24.0s for the IASP91 model), it is possible to estimate the variation in the thickness of the mantle transition zone and the temperature variation in the ambient mantle. The main goal of this paper is to investigate the transition zone discontinuities of upper mantle in northwest of Zagros using P receiver function and to verify whether areas, introduced by SUNA for geothermal energy in the whole study area, are suitable areas for this purpose or not.

Methodology and Approaches

Data have been selected from teleseismic events ($M_b \geq 5.5$, $30^{\circ} < \triangle < 95^{\circ}$) that have been recorded between 2004 to 2016 at 12 short period and broadband stations. Methodology of P receiver function analysis is used in this paper. A time window of 110 s has been considered, starting from 10 s before the P-onset arrival time. First, the instrument response is denconvolved from the original records. ZNE components are then rotated into the local LQT ray-based coordinate system. A low-pass filter of 5 s is applied to the P receiver functions. They are stacked after move out correction for a reference slowness of 6.4 s/°.

Results and Conclusions

The P receiver functions for all stations in the study area have been calculated. Theoretical differential time of converted phases of 410 and 660 km discontinuities for the IASP91 model is 24.0 s at 67° (or 6.4 °/s slowness) has been determined . The two global discontinuities at 410 and 660 km have been observed, which are, respectively, identified 1 s and 2.1 s sooner than predicted by the IASP91 reference model. The differential time between both

discontinuities is ~23 s and less than that of IASP91 model. The transition zone is still thinner, which is probably due to temperature anomaly and causes a reduction in seismic velocities (V_P, V_S). The P-to-S conversion points are located in Sanandaj-Sirjan and Uromieh-Dokhtar zones. Two dimensional (2D) migrated sections along two survey lines with direstions of NE-SW and W-E have also been obtained. As the results show the transition zone discontinuities of upper mantle are visible. These discontinuities at the depths of 410 and 660 km are not flat as the temperature anomaly in these depth indicates, and can also be derived from the standard IASP91 global earth model. Both discontinuities appear to be depressed in the central portion of the survey lines. The maximum temperature anomaly is equal to 180˚C and 450˚C at 410 and 660 km discontinuities, respectively. As a result, this could mean that the upper mantle in these regions is still influenced by several geodynamical processes which makes these regions suitable for geothermal energy as SUNA has suggested.