Appendix C

Probing the north Iranian crust

An overview

The Iranian Plateau being trapped between converging Arabian and Eurasian plates is under extensive crustal deformation and shortening. To study the structure of the crust and topography of the crust−mantle boundary in northern Iran where Alborz mountains border the Central Iran province the Receiver Function method is being applied to the teleseismic earthquakes recorded by the Tehran Telemetry Seismic Network (TTSN)− a short period digital network made up of 12 stations in northern Iran. The results of the analysis of recorded events during 1997−2001 by two stations, QOM and MHD show clear P−to−S conversions from the crust−mantle boundary at 5.4 sec and 6.3 sec, relative to direct P arrival, respectively. A combination of receiver functions modeling and simultaneous search for optimum crustal thickness and Vp/Vs ratio corresponding to aforementioned delay times speak of crustal thicknesses of 44 km and 48 km beneath MHD and QOM stations, respectively. These rather large values of crustal thickness are expected considering the long history of crustal shortening in Iranian Plateau and are consistent with results obtained by other geophysical methods. Some strong intracrustal discontinuities are also observed in receiver functions which show indications of an intracrustal discontinuity at approximately 20 km depth under the aforementioned stations.

A brief account of the results achieved by applying receiver function methodology to teleseismic data recorded by stations of the Tehran Telemetry Seismic Network (TTSN) (Figs. C.1 and C.2) is given here. Analysis of more than 30 teleseismic events recorded by QOM and MHD stations (Fig. C.1) are presented in Figs. C.3 to C.5. The values of the crustal thickness obtained are in general agreement with gross estimation of Moho depths (Fig. C6) across the Iranian plateau. While the crustal thickness values are well controlled within a few kilometers the values of Vp/Vs, are more subject to strong variations and hence uncertainties. This can only be improved through availability of more good quality data and making the estimations for neighboring stations.

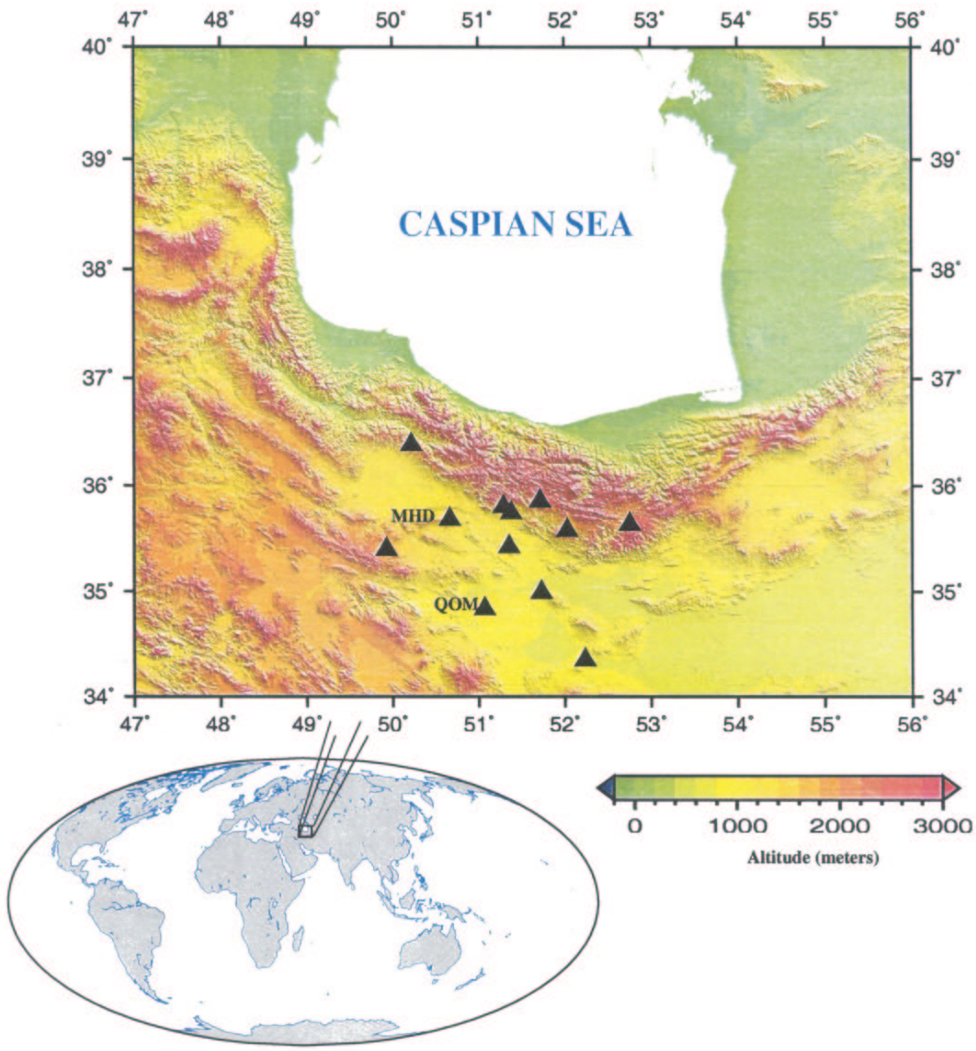


Fig. C.1 Location map showing the distribution of 12 stations of the Tehran Telemetry Seismic Network (TTSN) in northern Iran. The elevation data are from USGS GTOPO 30, a global elevation data model with 30" arc second resolution. Two stations of the network, QOM and MHD whose data have been used in this study have been annotated.

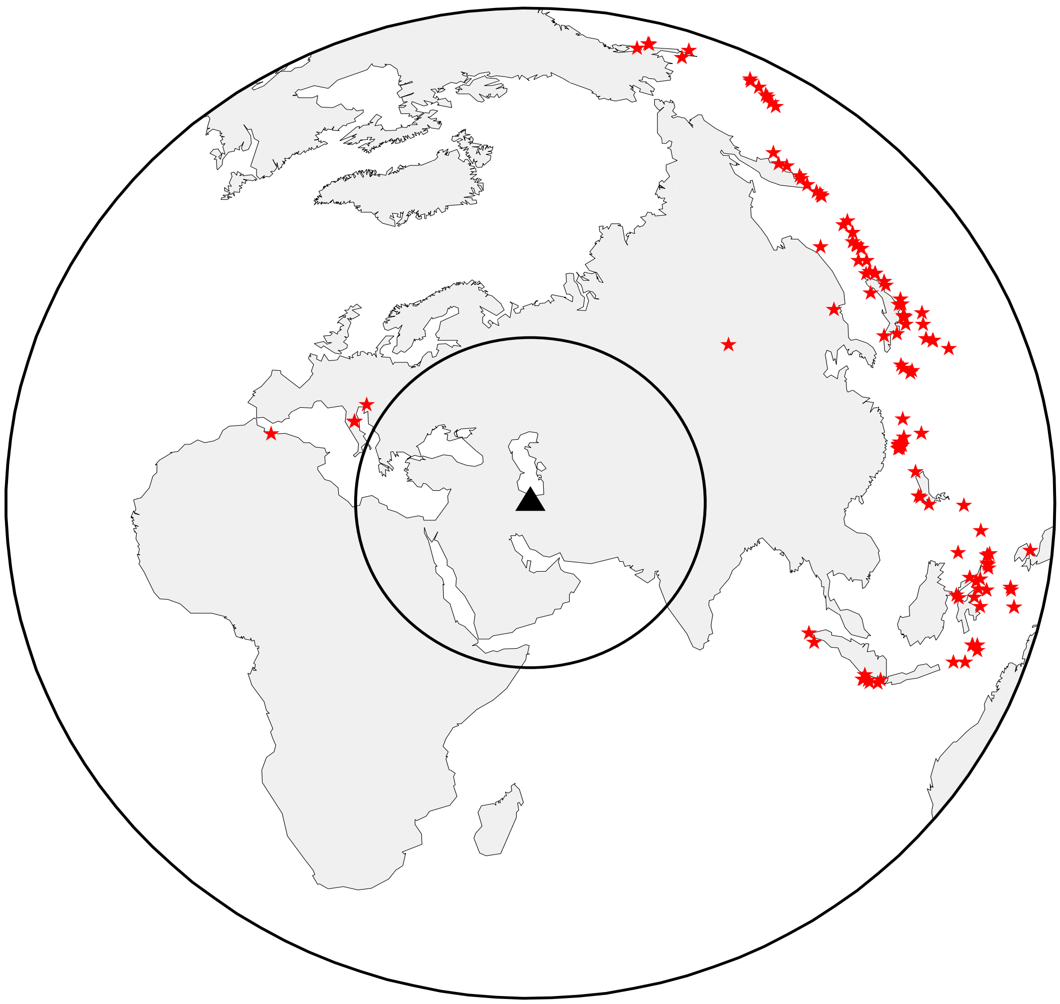
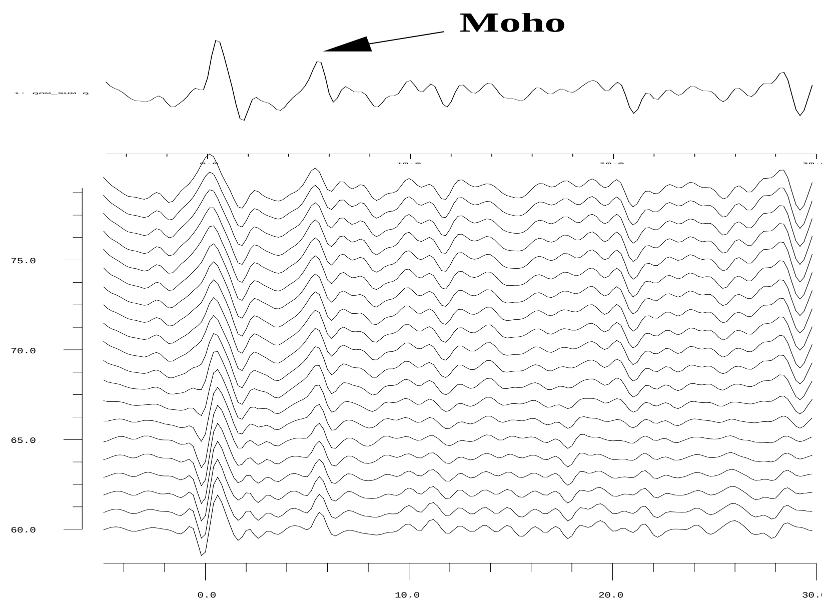
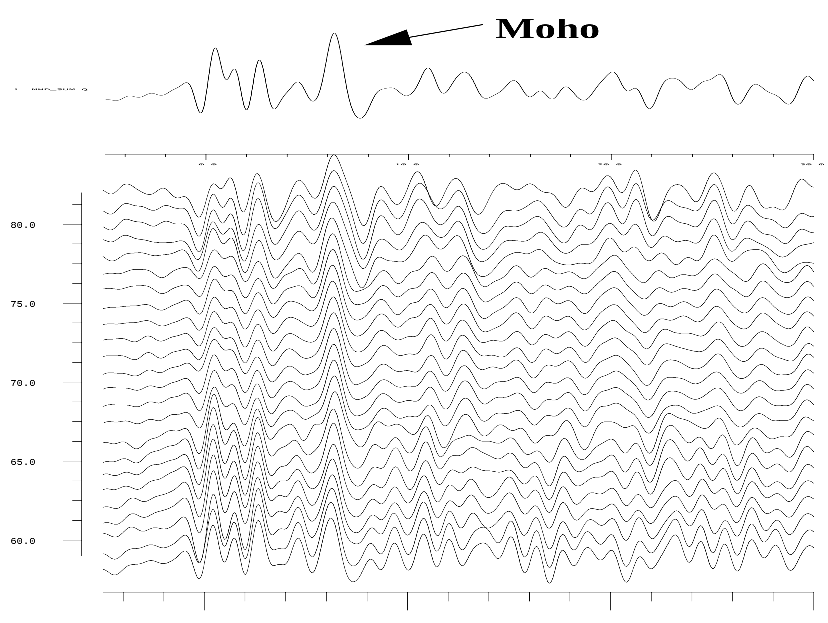


Fig. C.2 Distribution of 129 teleseismic earthquakes (red stars) as recorded by Tehran Telemetry Seismic Network (TTSN) during 1997−2001 (M > 5.7) and used in this study. The inner circle marks the 30° epicentral distance and the black triangle represents the approximate position of the the network.

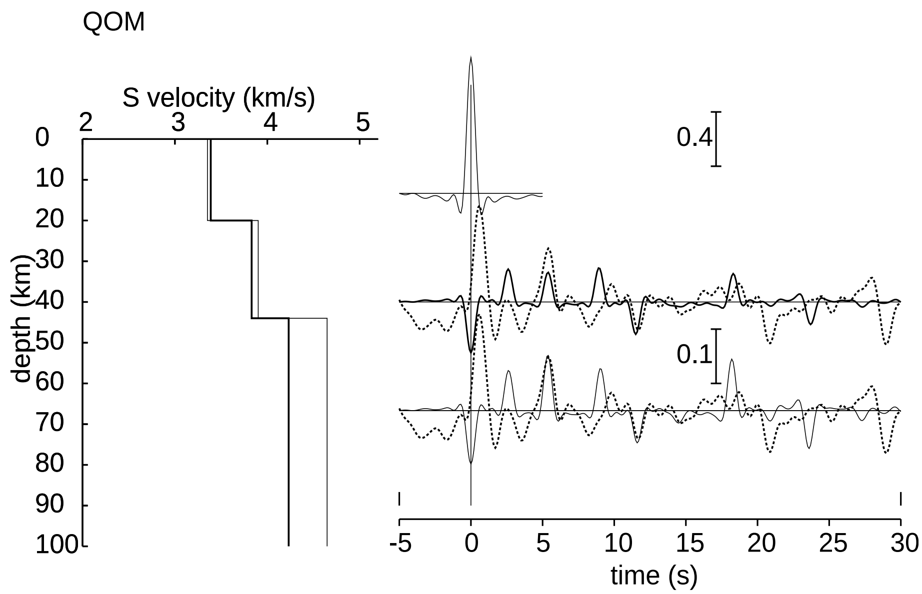


(a)

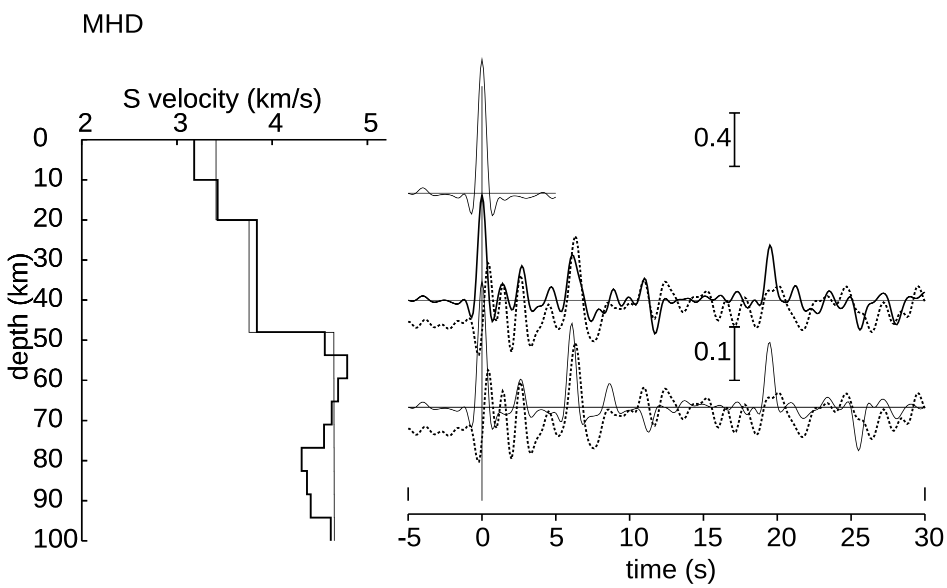


(b)

Fig. C.3 Move−out corrected and stacked receiver functions calculated for QOM (a) and MHD (b) stations displayed according to epicentral distances of earthquakes. The traces are the results of applying the moving average technique of summing traces in 10° wide windows which move in intervals of 1° from south to north. Traces depicted on top of each panel with the Moho conversions marked are sum of all displayed traces. The horizontal scales are delay times (sec) relative to direct P arrivals.

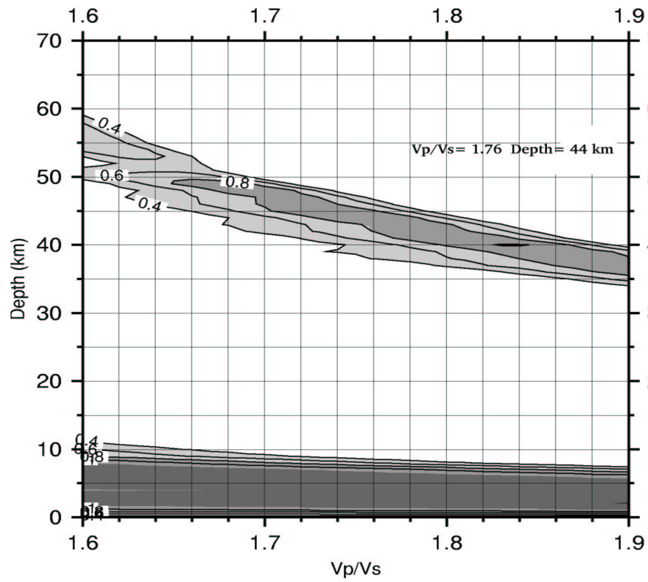


(a)

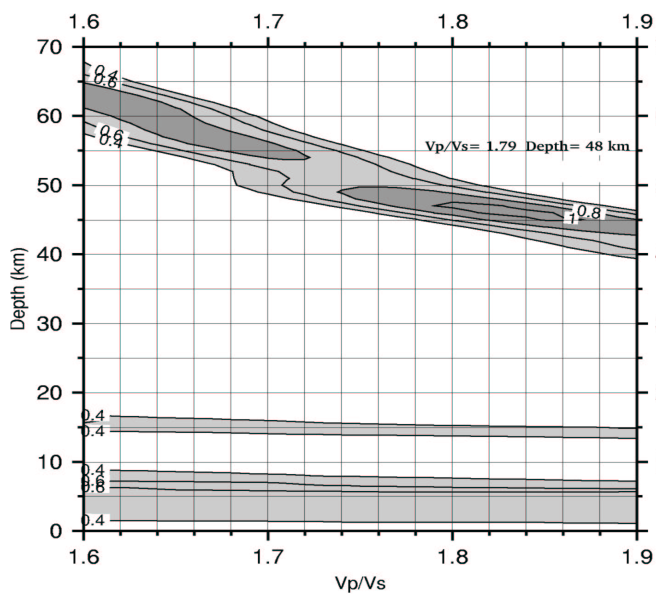


(b)

Fig. C.4 Results of receiver function inversion (*Kind et al. 1995*) at QOM (a) and MHD (b) stations for lithospheric structure beneath the station. The Left panels show the start model (thin line) versus the final model (thick line) whereas in the right panel the synthetic RF for the starting model (thin line) along with the RF from the final model (think line, bottom traces) and the observed RF (dotted line) are shown. The results show clear Moho conversions at depths of around 44 km and 48 km at QOM and MHD stations, respectively. Midcrust conversions at 20 km depths are also observed at both sites.



(a)



(b)

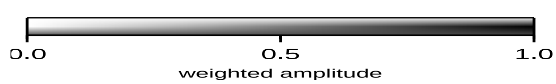


Fig. C.5 Estimated depths to the Moho, underneath QOM (a) and MHD (b) stations using Zhu & Kanamori method (*Zhu & Kanamori 2000*) of simultaneous varying the crustal thickness and Vp/Vs in search for the optimum solution. Crustal thicknesses of 44 km at QOM and 48 km at MHD stations are in good agreement with direct reading of the Moho phases from stacked receiver functions (Fig. C.3) and the inversion outputs (Fig. C.4).

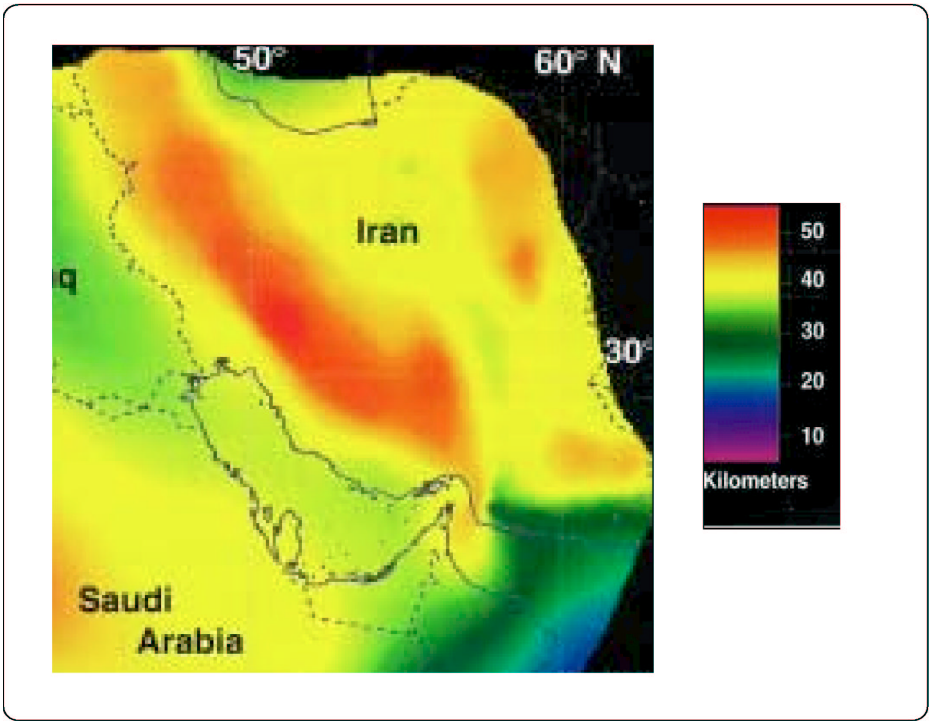


Fig. C.6 A simplified map of the crustal thickness in Iran and neighboring countries compiled from various sources (after *Seber et al. 1997*). The estimated Moho depth of more than 40 km shown here across northern Iran is in general agreement with results presented here.

Conclusions and implications

In this ongoing study I have drawn upon the effectiveness of the receiver function methodology to probe into the crust of the northern Iran. The presence of a number of permanent seismic stations has provided the opportunity to use the recorded strong teleseismic events for crustal structure studies. The preliminary results obtained from the analysis of data from two stations located in "Central Iran" and Alborz Mountains" structural provinces show crustal thicknesses of around 45 km. Seen in the light of a long history of crustal shortening of Iranian Plateau these values seem plausible. It is hoped that by processing the whole dataset available from permanent stations in the region a better understanding of the relation between active tectonics at work and deep structures in the crust can be achieved. Detailed mapping of the crust–mantle boundary can reveal for example if there is a root under the Alborz Mountains which is genetically part of the Alps–Himalayan orogeny. Or, to what extent surface geology and present tectonic settings are related to deep crustal structures. Addressing these issues could shed some light on the mechanism of formation and history of deformation of the Iranian Plateau.

References

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