CRUSTAL GEOMETRY AND TRASNSITION ZONE BOUNDARIES BENEATH IRAN

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ABSTRACT

We reanalyzed P receiver functions beneath a 1200 km long profile from Bushehr to Sarakhs to investigate the variation of crust–mantle boundary beneath the Zagros continental collision zone. Our results shows a rapid change of Moho boundary 60 km north of MZT implying that the MZT extends through the entire crust. we also image upper mantle transition zone by detecting two velocity discontinuities at about 410 km and 670 km depth. The boundaries are continues and constantly separated. This may imply low dip angle subduction of Arabian slab beneath Central Iran in the past.

INTRODUCTION

Late Mesozoic convergence of Arabian plate towards Eurasia made a subduction process beneath Central Iran followed by a continental collision between ~35 to 12 Ma (e.g., Mouthereau et al., 2012, and references therein). This convergence is accommodated at a rate of ~ 25 mm/yr across the Iranian Plateau and the surrounding mountain ranges and resulted in different styles of deformation in different parts of this continental collision zone. The convergence caused a ~67 km crustal root in north of Zagros Mountains and in front of an ophiolitic suture zone between Arabian Plate and Central Iran, called Main Zagros Thrust fault (MZT) (Paul et al., 2006, 2010).

From 2000 November to 2001 April, Paul et al. (2006) operated a network of 66 seismological stations along a profile almost perpendicular to the tectonic strike of Zagros. This profile was extended from the Persian Gulf coast across Zagros, Sanandaj–Sirjan Zone (SSZ) which is a highly deformed and moderately metamorphosed remnant of the southern margin of Central Iran, Urumieh–Dokhtar magmatic arc (UDMA) which is characterized by volcanic activity from Eocene to Miocene, and southern part of Central Iran (Fig. 1). Paul et al. (2006) did the first effort to investigate the crustal thickness variation along a line perpendicular to continental collision margin, beneath MZT.

Here, we re-evaluate the crustal thickness variation across Zagros profile using P to S converted teleseismic waves, called P receiver function (PRF). We also image transition zone by detecting two velocity discontinuities at about 410 km and 670 km depth. To expand our study area, we used dataset of NE Iran profile which is described by Motaghi et al. (2012). This profile includes 17 broad-band stations and is a continuation of Zagros profile with a similar trend (Fig. 1). The merged profile from combination of Zagros profile and NE Iran profile is a 1200 km long profile crossing most important tectonic features in Iranian Plateau. We used 209 teleseismic records of 7 earthquakes with magnitude 6.5 or greater and epicentral distances between 30° and 90° recorded by Zagros profile. We added 137 records of 13 earthquakes with magnitude 7 or greater in the same epicentral distance range (Fig. 2). We used big earthquakes to be cautious about noise and low quality signals.

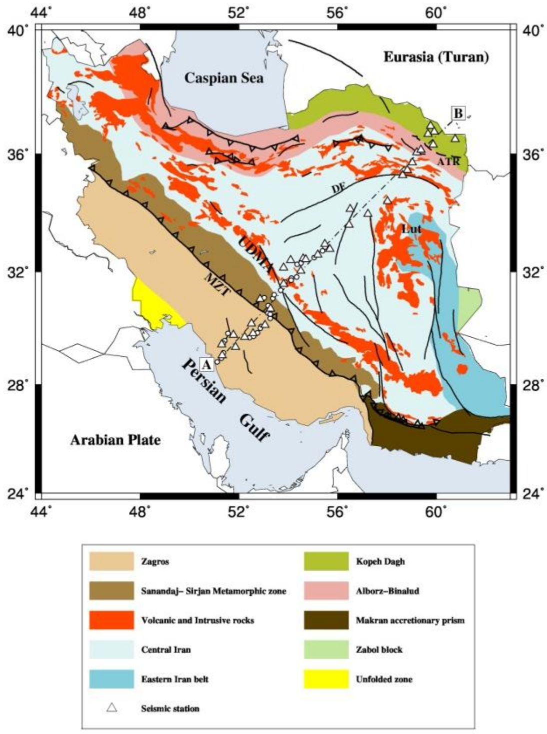

Figure 1. Location map of the seismological network on the geological map of Iran. Circles and triangles denote short period and broad-band stations, respectively.

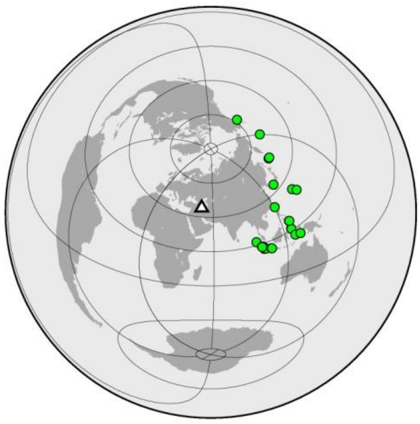

Figure 2. Distribution of the events used in this study (circles) in relationship to the studied area (triangle)

Figure 3 shows a rapid change of Moho boundary 60 km north of MZT, marked by black vectors in Figure 3-b. This offset is observable in positive correlated PpPs multiples marked by black vectors in Figure 3-c. This geometry may imply that the MZT extends through the entire crust. Earthquakes along this fault are limited to the upper 15 km, which reflects the brittle deformation in the upper crust. Our result suggests Arabian continental crust under-thrusts beneath Central Iran continental crust in front of thrust suture zone, probably due to drag pool of oceanic slab subduction. The 410 km and 660 km boundaries marking the top and bottom of the mantle transition zone are well imaged beneath Iranian Plateau on the seismic profile (Fig. 3-d). Experimental studies have shown that both boundaries are sensitive to temperature and have Clapeyron slopes of opposite signs. In the absence of other effects, a lateral increase in temperature at the level of the transition zone should be reflected in a deepening of the 410-km discontinuity and a shallowing of the 660-km discontinuity and vice versa. The continuity and the constant separation of the 410 km and 660 km boundaries implies that there is no lithosphere slab penetrating the mantle transition zone beneath Iranian Platuea even 900 km farther apart suture. It implies low dip angle subduction of Arabian slab beneath Central Iran.

CONCLUSIONS

In this study, we present the crustal thickness variation across a long profile crossing most important tectonic features in Iran. The features beneath continental collision is complicated, so we kept only high quality signals from big events. In this way, we calculated 349 high quality P receiver functions. The migrated section of PRFs shows a dislocation of Moho boundary north of MZT which might be a signature of a broken crust in front of MZT. This geometry may imply that the MZT extends through the entire crust. We also imaged the upper mantle transition zone by detecting two velocity boundaries around 410 km and 660 km depth. The resolved boundaries are continues and separated constantly implying that there is no anomalous features inside the transition zone even several hundred kilometres north of the suture zone. This may imply low dip angle subduction of Arabian slab beneath Central Iran in the past.

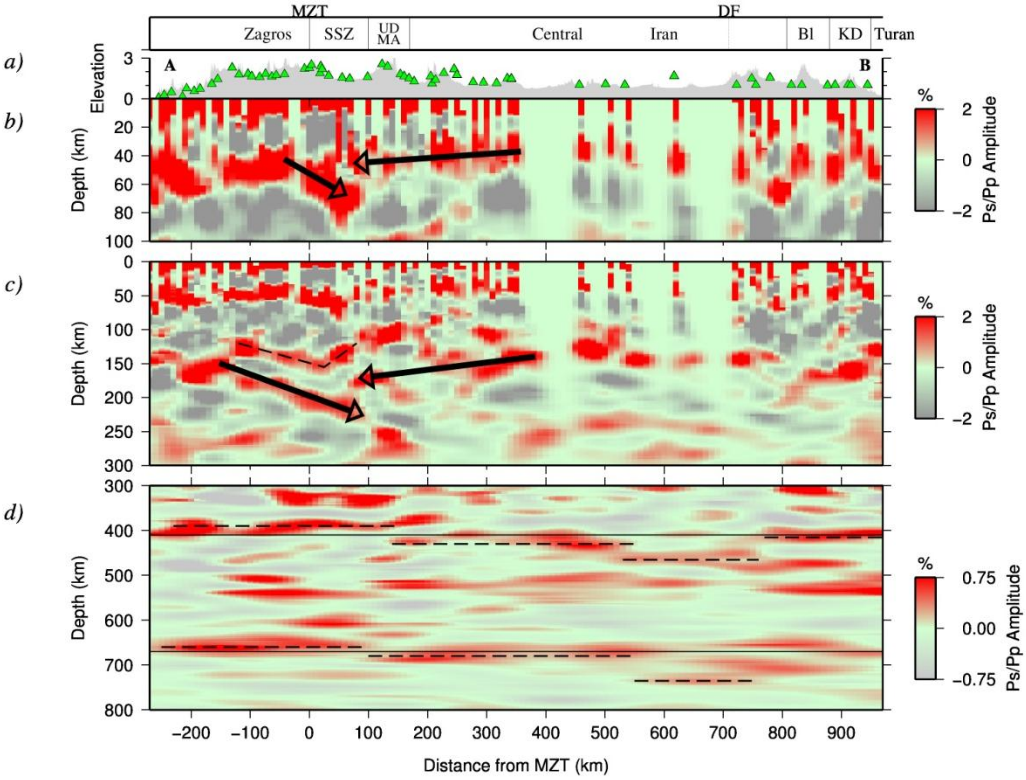

Figure 3. Depth migration of 349 P-receiver functions beneath Zagros profile (x < 300 km) and NE Iran profile (x > 300 km). Vectors mark rapid change of crustal thickness in front of MZT.

REFERENCES

Motaghi K, Tatar M and Priestley K (2012) Crustal thickness variation across the northeast Iran continental collision zone from teleseismic converted waves, *Journal of Seismology*, 16: 253–260

Mouthereau F, Lacombe O and Vergés J (2012) Building the Zagros collisional orogen: timing, strain distribution and the dynamics of Arabia/Eurasia plate convergence, *Tectonophysics*, 532–535: 27–60

Paul A, Kaviani A, Hatzfeld D, Vergne J and Mokhtari M (2006) Seismological evidence for crustal-scale thrusting in the Zagros mountain belt (Iran), *Geophysical Journal International*, 166: 227–237

Paul A, Kaviani A, Hatzfeld D, Tatar M and Pequegnat C (2010) Seismic imaging of the lithospheric structure of the Zagros mountain belt (Iran). In: Leturmy, P., Robin, C. (Eds.), Tectonic and Stratigraphic Evolution of Zagros and Makran During the Meso-Cenozoic. Geological Society, London, Special Publications, 330: 5–18