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UPPER MATNLE STRUCTURES OF THE NW IRAN USING 3D TELESEISMIC TOMOGRAPHY

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INTRODUCTION

The Zagros mountain range is part of the Alpine-Himalayan Orogenic belt, and has formed as a result of the convergence between the Arabian and Eurasia plates. Most of the Iranian plateau is affected by complex Cenozoic geodynamic processes due to subduction and closure of the Neo-Tethys Ocean beneath the SW margin of Central Iran. This subduction followed by volcanism, slab detachment, possible mantle erosion in the overriding continent, and the final formation of the Zagros mountain belt and related tectonic provinces. The collision between Arabia and Iranian micro-continent started in the Early Miocene (~16-23 Ma) and final closure of the Neo-Tethys Ocean is suggested at ~12 Ma. The convergence of the Arabian plateau towards Central Iran (~25 mm/yr) is accommodated by transpressional faulting in the middle and southern part of the belt, and slip partitioning in the northern part throughout the simple fold thrust belt (SFTB) and the Main Zagros Thrust (MZT). In this study, we perform a 3D teleseismic tomography using relative teleseismic P wave travel times to estimate the relative velocity structures of the upper mantle and part of the lower mantle of the Iranian plateau to the depth of 800 km.

We used 26000 P wave teleseismic relative travel times, recorded by Zagros01, Zagros03, Iran-China temporary networks and Iranian Seismological Center (ISC) and International Institute of Earthquake Engineering and Seismology (IIEES) permanent networks. Before inverting data we performed Moho depth, station elevation, and Earth radius variation corrections. For calculating the Moho depth variations, we performed a receiver function analysis on the three temporary networks and estimated the Moho depth corrections. We used the Aki et al. (1977) method for performing teleseismic tomography. In order to invert our data, we need to parameterize our study region. To do so we had divided our study region into 25×25×25 km blocks. For dealing with the singularity of Jacobean Matrix, estimation of the relative velocity in the underdetermined part of the model, and smoothing of the output model, we add damping and smoothing constraints to the Jacobean Matrix, and finally, we invert the data using the LSQR method.

In general, our tomography images show high-velocity anomalies beneath the Arabian part of the Zagros and low-velocity anomalies resolved underneath the region north of MZT to a depth of 200 km. The forehead of the high-velocity anomalies at the depth of 200 km extend 150 km north of the MZT beneath the western part of Zagros03 network (Figure 1-c), which agrees with lithosphere-asthenosphere boundary (LAB) reported by (Motaghi et al., 2017). This can be a consequence of more lithospheric underthrusting of these areas relative to the northwestern part of the model.

We can distinguish two high-velocity anomalies, the first one is located at ~150 km north of MZT with a depth estimation between ~200 km to ~350 km in the northwestern area (Figure 1-a and 1-b) and the second one located at 350 km north of the MZT with depth between ~300 km to ~400 km beneath the Zagros03 network (Figure 1-d).These anomalies can be the result of mantle erosion in these locations. We suggest that, after oceanic slab detachment, the asthenospheric material penetrated under the thickened and thus unstable mantle beneath central Iran and caused detachment of the mantle lithosphere into deeper part of upper mantle. At the deeper part of our tomography images (>~200 km), we can distinguish a high-velocity anomaly that starts from ~100 km south of the MZT and extends ~50 km north of the MZT. This anomaly continues to depth of ~550 km in the northwestern part of our model (Figures 1-a and 1-b). In the middle part, this anomaly penetrates to depth of 700 km (Figures 1-c and 1-d). This might happen because of the low resolution in deeper parts of our model at the northwestern areas. Agard et al. (2011) proposed that the oceanic slab was steeped after the collision between Arabia and Eurasia; this high-velocity anomaly can be an indication of a steeped oceanic slab. As mentioned above the anomaly starts from 100 km south of the MZT and can be interpreted as the signature of a slab broken off at 12 Ma as suggested by Hafkenscheid et al. (2006). If we accept this interpretation, we then have two distinct geodynamic components; the Arabian lithosphere which converges towards the Eurasia plate through underthrusting the southern margin of Central Iran, and the broken high-angle oceanic slab that remains almost steady and keeps penetrating the lower mantle. This geometry is in accord with its low vertical velocity due to penetration into the lower mantle. This is also in agreement with Hafkenscheid et al. (2006) suggestion that the oceanic slab is penetrating into the lower mantle of the Zagros orogeny.

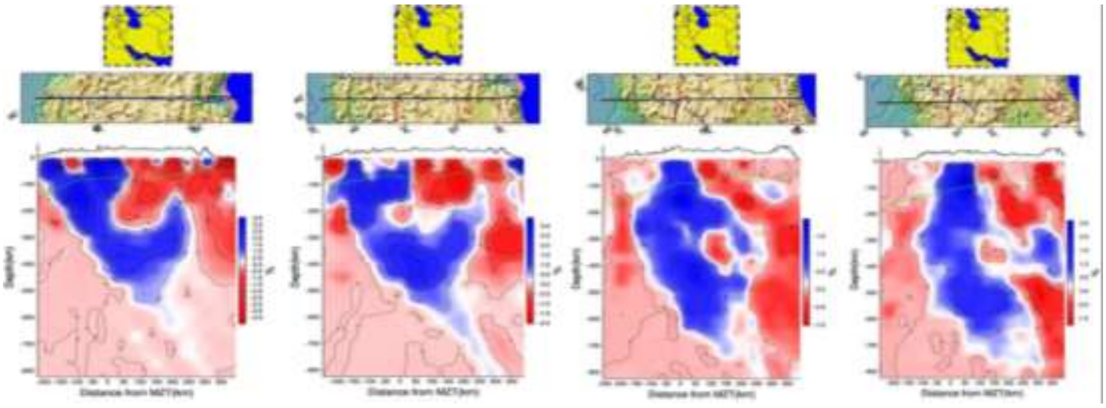

Figure 1. Results of the teleseismic tomography beneath the northwestern part of Iranian plateau.

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