# UPPER MANTLE STRUCTURE BENEATH THE ZAGROS CONTINENTAL COLLISION ZONE AND SURROUNDING REGIONS FROM SEISMIC TOMOGRAPHY AND SHEAR-WAVE SPLITTING

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Study of collision zones can provide insight into the dynamic processes involved in the formation and evolution of the orogenic belts. Many topics are under debate about the dynamic processes of the upper-mantle beneath the Zagros collision zone and Iranian plateau. An important question is how the convergence between the Arabian and Eurasian plates deformed the upper mantle beneath the Iranian plateau. Moreover, the fate of the subducted lithosphere is an important issue that is still a subject of debate. To figure out the dynamics of the collision, we have used seismic tomography and shear wave splitting to investigate the deep structure of the Zagros and its surrounding regions. To unravel the upper mantle processes related to the collision, a proper dataset consisting of 32738 *P*-wave relative arrival time residuals have been picked from 1982 distant earthquakes recorded in 129 seismic stations. The residual patterns are mapped as 3-D perturbations in *P*-wave velocity using a nonlinear teleseismic tomography method (Rawlinson et al., 2006). To estimate the dynamical processes in the continental collision, it is important to figure out the accommodation of convergence and flow behaviors in the upper mantle. We used an unprecedented dataset, consisted of 3260 core-refracted shear phases to probe the fast polarization directions and delay times of shear waves propagating through anisotropic structures beneath each seismic station using energy minimization of transverse components (Silver & Chan, 1991).

The *P*-wave velocity model show a relatively thick (>150 km) high-velocity anomaly beneath the northern part of the collision zone, which could be the thickened Zagros lithosphere that probably is responsible for active continental shortening. Besides, the cumulative processes of Neotethyan flat-slab subduction in the middle of Cretaceous, mantle preconditioning by dehydration of the subducted plate, slab roll back in the Eocene and tectonic erosion driven by convective flow before the collision, are partially responsible for the weakened mantle lithosphere beneath the Alborz and Central Iran (Mahmoodabadi et al., 2019). The Quaternary volcanic activities in the Alborz could be the result of these processes. We observe a segment of the Neotethyan oceanic slab, which is detached from the continental leading edge.

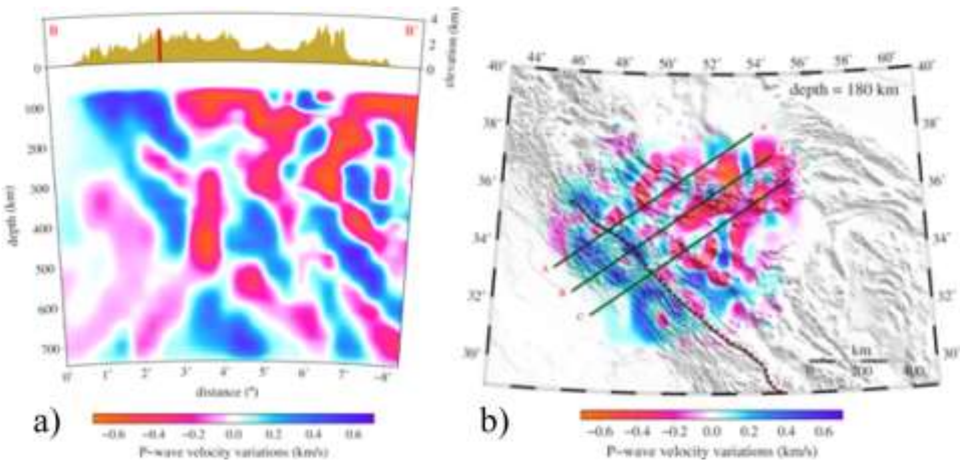


*Figure 1. a) cross-section, and b) depth section through the P-wave tomography model.*

Our results suggest that the Arabian mantle lithosphere plays an important role in accommodating the convergence between the Arabian and Eurasian plates. High seismic activity to the west of the suture and lack of seismic activity to the east may support this hypothesis. Shear wave splitting observations suggest that both lithosphere and asthenosphere have a contribution to the mantle anisotropy over the plateau. A simple asthenospheric flow cannot justify the mantle anisotropy data in the region. Deformation has thickened the Zagros lithosphere which perturbs the asthenospheric flows, and Slab-breakoff makes room for these flows. Shear wave splitting observations show the possibility of a rotational flow around the Zagros lithosphere which may confirm its thickening and deformation. The low velocities beneath the Central Iran lithosphere in the vicinity of the Zagros orogeny may confirm these flows, which may also play role in thinning the Central Iran lithosphere. Our observations suggest that both simple-shear and pure-shear processes, due to the continental collision forces, deform the upper mantle beneath the Iranian plateau, and in some areas, crust and mantle are deformed coherently through these processes.

## REFERENCES

Mahmoodabadi, M., Yaminifard, F., Tatar, M., Kaviani, A., and Motaghi, K. (2019). Upper mantle velocity structure beneath the Zagros collision zone, Central Iran and Alborz from nonlinear teleseismic tomography. *Geophys. J. Int.*, *218*(1), 414-428, doi:10.1093/gji/ggz160.

Rawlinson, N., Reading, A.M., and Kennett, B.L.N. (2006). Lithospheric structure of Tasmania from a novel form of teleseismic tomography. *J. Geophys. Res.*, *111*(B2), doi:10.1029/2005JB003803.

Silver, P.G. and Chan, W.W. (1991). Shear wave splitting and subcontinental mantle deformation. *J. Geophys. Res.*, *96*(B10), 16429–16454, doi:10.1029/91JB00899.