Mantle thermal conditions of the Zagros collision zone and surroundings

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Fig. 1

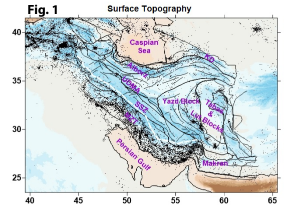
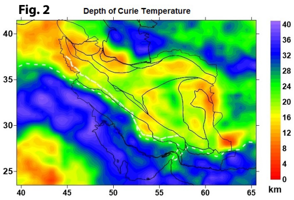


Fig. 2



Abstract

Late Mesozoic convergence between the Arabian plate and Eurasia generated subduction of the Neo-Tethys ocean beneath Central Iran and the onset of the closure of the oceanic domain in the Late Cretaceous. The final closure of the Neo-Tethys ocean (~12 Ma) formed the Zagros collision zone composed of different parallel tectonic features from southwest to northeast: the Zagros Fold and Thrust Belt (ZFTB), the Sanandaj–Sirjan Metamorphic Zone (SSZ), and the Urumieh–Dokhtar Magmatic Assemblage (UDMA). The ZFTB is the young and seismically active zone of the Zagros Mountains and is separated from the SSZ by the Main Zagros Thrust (MZT), which is considered to be the suture zone between the Arabian and Iranian plates and assumed deeply rooted. The SSZ consists mainly of Precambrian metamorphic rocks and igneous rocks, whose formation is related to the subduction of the Neo-Tethyan slab. The UDMA hosts abundant Tertiary magmatism, dominantly of arc or island-arc type.

Currently, the convergence is accommodated across the Iranian Plateau and the surrounding mountain ranges, at a rate of 10–20 mm/yr, resulting in different styles of deformation in this active collision/subduction zone (e.g. Khorrami et al., 2019). Several models, based on the interpretation of seismic tomography and receiver function data, revealed high velocities beneath the Zagros in the upper mantle down to depths exceeding 200 km, implying a relatively thick lithospheric mantle (e.g., Priestley and McKenzie, 2006). Furthermore, according to some authors, thick high-velocity lithosphere of Arabian Plate is extended beneath UDMA and southeastern Central Iran (e.g., Mahmoodabadi et al., 2020), while based on some others, thin lithosphere characterizes the UDMA (Mohammadi et al., 2013) and the SSZ (e.g., Manaman et al. 2011). Therefore, up to now, a consensus has not been reached on the maximum depth neither on the lateral extension of the subducting Arabian lithosphere. Other uncertainties are related to the dip and nature of the slab. In order to address these controversial issues, we analyze global (Schaeffer and Lebedev, 2013) and regional (Koulakov et al., 2011) seismic tomography models and convert their absolute velocities in temperature, assuming a composition taken from studies on xenolith samples (McDonough and Sun, 1995; Nasir et al., 2006), representative of a Phanerozoic and Proterozoic mantle, characterizing Central Iran and Zagros collision zone, respectively (Figs. 3-8). Indeed, the conversion in temperatures allows us to better identify the shapes of the upper mantle features. To this purpose, we use Perple_X (Conolly, 2005) that computes physical properties for a given mineralogical model, expressed by the main mantle oxides. In addition, we compare the results obtained with the seismicity distribution (1976-2022, M>= 2.5, Fig. 1, https://www.usgs.gov/programs/earthquake-hazards/national-earthquake-information-center-neic) and the depth of the Curie point (Fig. 2, Li et al., 2019), in order to improve our understanding of the geodynamic setting of the area.

Our results show that the northern part of the collision zone, where the subducting slab extends beyond the boundary between ZFTB and SSZ, is characterized by high topography, having sharp lateral changes (cross-sections a-a' and d-d'). In contrast, in the central part of the collision zone, the topography is high at the ZFTB and suddenly decreases, showing a smoother trend at the SSZ. We relate these variations to the presence of a thermal anomaly (cross-section e-e'), indicating a partial slab detachment.

Fig. 3, Fig. 4, Fig. 5

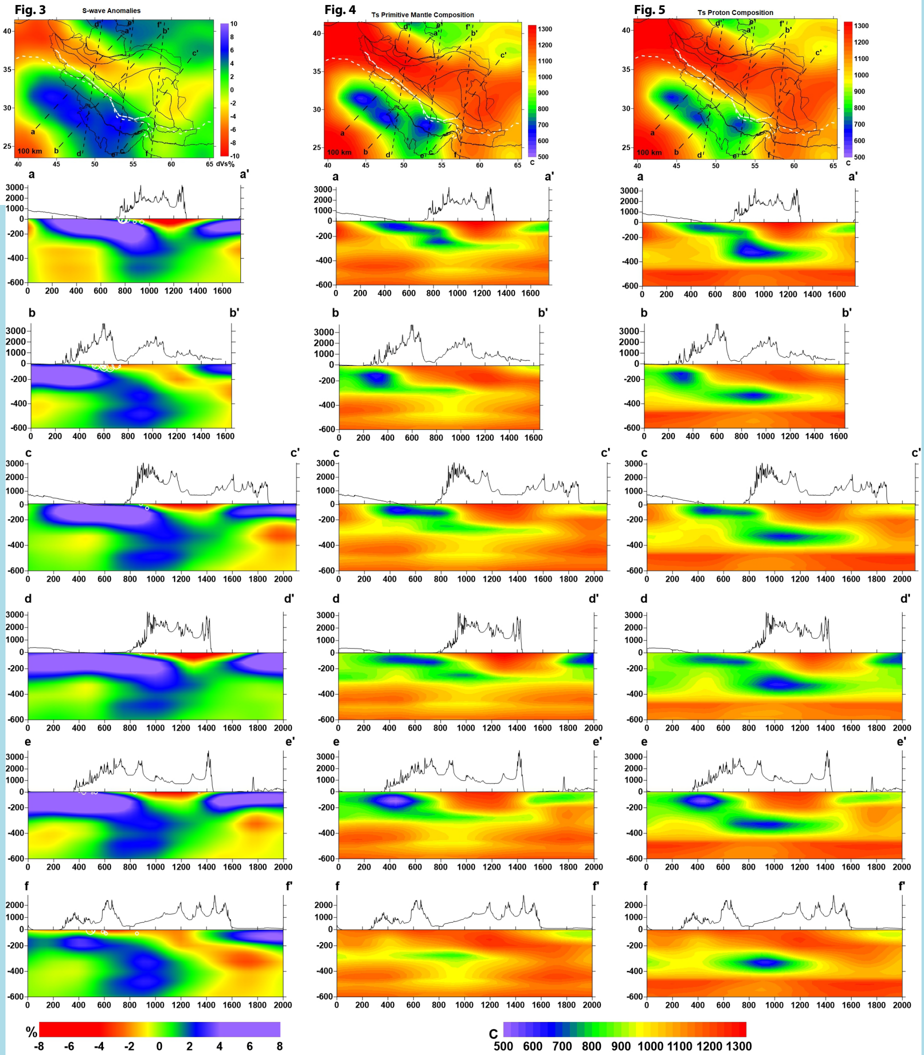
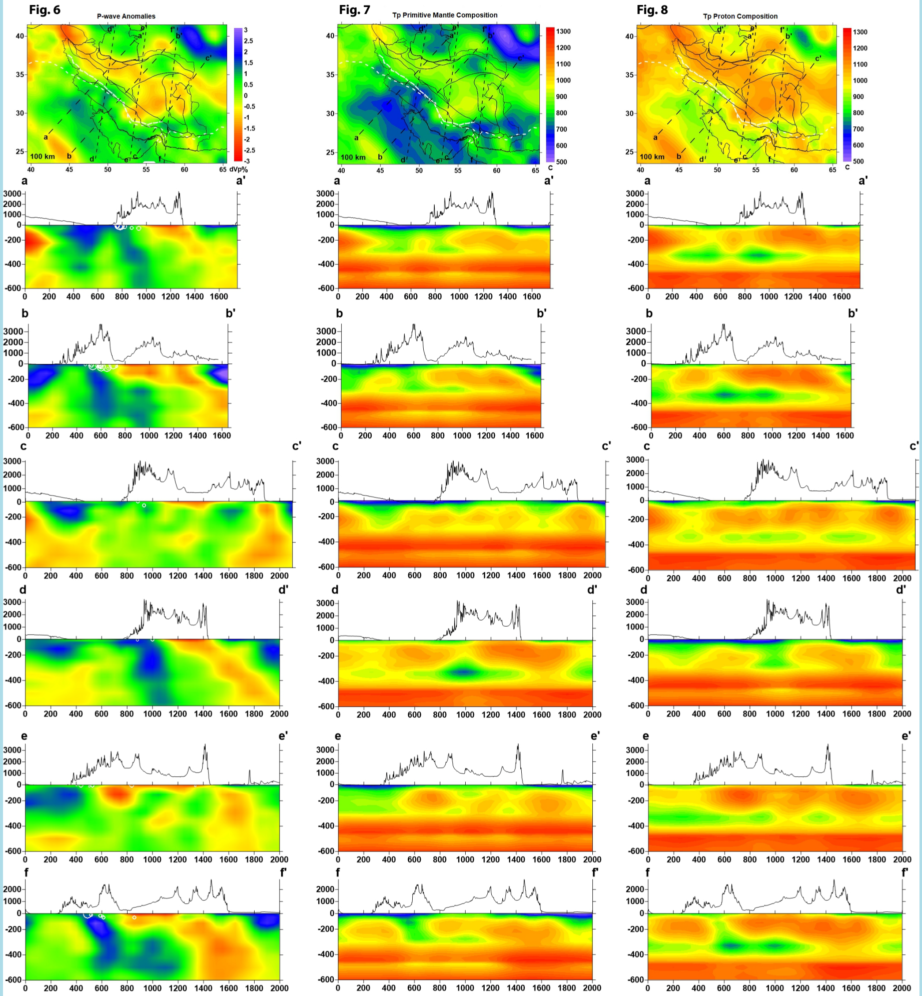


Fig. 6, Fig. 7, Fig. 8



* Vertical topography variations are in m, while lateral and verical variations of the velocity anomalies and temperatures are in km

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