Structure and Rheology of the Arabia-Eurasia Zagros and Makran Plate Boundaries Inferred From Pn-Tomography

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ABSTRACT

The objective of this study is to infer the state of the upper mantle at the Arabia-Eurasia plate boundary, along the Zagros Collision and the Makran Subduction Zones. In this study, we use Pn-tomography method to map lithospheric mantle velocity and anisotropy at the Arabia–Eurasia plate boundary. Pn phase is a guided high-frequency P-wave that propagates between the Moho and the Low Velocity Zone (LVZ) of the upper mantle. Pn-velocity is often used to infer the state of the uppermost mantle, high Pn velocity indicate a stable upper mantle, while slow Pn velocity indicates unstable upper mantle perhaps with melt or associated volcanism. Tomography methodology is similar to T-Scan used in medicine, but in this case is used to image changes of velocity in the upper mantle. We used catalogue events for the period 1998 to 2010 recorded by Oman, UAE, Saudi Arabia, and Iran national earthquake monitoring networks, and catalogue events from the International Seismological Centre and the National Earthquake Information Center. Events at 1.8 to 16 degrees distance from recording stations were used as inputs for this Pn-tomography study. The results show that the northeastern Arabia plate is characterized high Pn-velocity, indicative of a cold and stable lithospheric mantle beneath Arabia. Contrastingly, Eurasia is underlain by slow Pn-velocity, indicative of hot and unstable lithospheric mantle beneath the Eurasia Plate. They also show that the Arabia–Eurasia lithospheric suture follows the Zagros Collision suture at the surface, within c. 70 km lateral proximity. In the southernmost Zagros Collision Zone the Arabia lithosphere is inferred to extend farther northeast beneath the Lut Block. This may be the extended subduction of Arabia Plate beneath Eurasia at this southernmost Zagros Collision Zone. In the Makran Subduction Zone, we find that the eastern Makran is showing typical subduction characteristics, with oceanic lithosphere in the eastern Oman Sea (inferred from fast Pn-velocity) and hot unstable lithospheric mantle below the overriding Helmand Block (inferred from slow Pn-velocity). Contrastingly, the western Makran subduction zone, including both Arabia and Eurasia continental sides is characterized by hot unstable lithospheric mantle (inferred by slow Pn-velocity). Slow Pn-velocity anomaly have also been found underlying the northern Oman region. This slow Pn-velocity anomaly is characterized by linear boundaries that coincide with subsurface Precambrian terrane boundaries of North Oman.