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Uppermost mantle velocity from Pn tomography in the Gulf of Aden

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We present an analysis of Pn traveltimes to determine lateral variations of velocity in the uppermost mantle and crustal thickness beneath the Gulf of Aden and its margins. No detailed tomographic image of the entire Gulf of Aden was available. Previous tomographic studies covered the eastern Gulf of Aden and were thus incomplete or at a large scale with a too low resolution to see the lithospheric structures. From 1990 to 2010, 49206 Pn arrivals were selected from the International Seismological Center catalogue. We also used temporary networks : YOCMAL (Young Conjugate Margins Laboratory) networks with broadband stations located in Oman, Yemen and Socotra from 2003 to 2011, and Djibouti network from 2009 to 2011. From these networks we picked Pn arrivals and selected 4110 rays. Using a least-squares tomographic code (Hearn, 1996), these data were analyzed to solve for velocity variations in the mantle lithosphere. We perform different inversions for shorter and longer ray path data sets in order to separate the shallow and deep structure within the mantle lid. In the upper lid, zones of low velocity (7.7 km/s) around Sanaa, Aden, Afar, and along the Gulf of Aden are related to active volcanism. Off-axis volcanism and a regional melting anomaly in the Gulf of Aden area may be connected to the Afar plume, and explained by the model of channeling material away from the Afar plume along ridge-axis. Our study validates the channeling model and shows that the influence of the Afar hotspot may extend much farther eastwards along the Aden and Sheba ridges into the Gulf of Aden than previously believed. Still in the upper lid, high Pn velocities (>8,2 km/s) are observed in Yemen and may be related to the presence of a magmatic underplating under the volcanic margin of Aden and under the Red Sea margins. In the lower lid, zones of low velocities are spatially located differently than in the upper lid. On the Oman margin, a low velocity zone (7.6 km/s) suggests deep partial melting. The Pn velocity below Socotra island is slower, whereas a high velocity zone is observed north of the Sheba ridge. The hot material may have flowed through Alula-Fartak transform zone towards Socotra.