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The Indian shield from the upper crust to the lower mantle: boundary layers and the fast drift

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The Indian shield of the Archean and Early Proterozoic age after the dispersal of Gondwana drifted to the North with a speed reaching 20 cm/year between 80 Myr and 55 Myr. Negi et al. (1986) argued that the mobility of the Idian subcontinent in the Mesozoic was facilitated by a thin (several tens kilometers) lithosphere. Kumar et al. (2007) published for the Indian shield an upper mantle model with the LAB at a depth of 100 km and the S velocity reduction of more than 10% in the LVZ under the LAB. In our work P and S receiver functions from seismograph stations in India are inverted jointly with teleseismic travel time residuald and provide a 2500-km cross-section of the crust and mantle between 75 and 80 degrees E. The mantle S velocity at depth less than 180 km is close to 4.5 km/s and never reaches 4.7 km/s, characteristic of the old shields. In our models there is neither the LAB at a depth of 100 km nor the LVZ with a significantly reduced S velocity, but the waveforms of the P410s and S410p seismic phases are indicative of a thin (a few tens kilometers) low velocity layer atop the 410-km discontinuity.
Studies of kimberlite pipes in central India indicate a mantle source extending in the diamond stabilty field at depths of more than 140 km. The pipes originated at 65 Myr with implication that the high-velocity mantle root of the Indian shield existed at least up to that time. It is likely that a metasomatic alteration of the uppermost mantle in India is young (Tertiary?) and inflicted by subduction-related fluids. In the heat-flow data there are no indications of this process. We cannot confirm the idea of a thin Indian lithosphere as a reson for its fast drift in the Mesozoic, because in the seismic data there is no robust marker for the lithosphere-asthenosphere boundary, and there is no evidence that the state of the Indian upper mantle in the Cretaceous was similar to the present state. Moreover, the upper-mantle velocities in the northern Greater India, buried in the Himalaya and Tibet are in a shield range. This means that the initial properties of the Indian shield beneath the Himalaya and Tibet are preserved better than in the rest of India. The depleted high-velocity upper mantle is less dense than its fertile counterpart, and this may explain why the high-velocity lithosphere was not subducted in the course of the continental collision. Another important effect revealed by our data is a pronounced difference in the
crustal velocities of the Indian Shield and the Himalaya/Tibet.