Crustal velocity structure from surface wave dispersion tomography in the Indian Himalaya

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Background

A network of 15 broadband seismographs in a ~500 km long, N-S array recorded 12 months of data in 2002-2003 (Rai et al. 2006). The array traverses the NW Himalaya, from the Indian plain in the south, across the Indus-Tsangpo Suture and the Tso Morari Dome, to the southern flank of the Karakoram in the north. Magnetotelluric (MT) studies in this region reveal low-resistivity zones which may be indicative of fluids, graphite, or partial melts in the mid-crust. We have tested these hypotheses by creating 1-D models of crustal shear wave velocity. The models contain low-velocity zones at 25–40 km depth; these may be indicative of fluids or partial melts.

Methods

Our models are obtained by inverting group velocity dispersion curves of Rayleigh waves in the period range of roughly 4–60 s. Numerous magnitude 4 events, several magnitude 5 events, and one magnitude 6 event occurred 900 km or less from the array. We find dispersion curves by analyzing the z-component of fundamental mode Rayleigh waves using Robert Herrmann's Computer Programs in Seismology (Herrmann and Ammon 2002). We invert the dispersion curves using these programs to create 1-D models of crustal shear wave velocity structure. The inversion is done to 150 km depth, but we consider only the upper 60 km of the models.

Results

Our results reveal, as expected, demonstrably different crustal structure in the Indian shield and the Himalaya and Tibetan Plateau, and our 1-D models suggest that a low-velocity zone is present immediately north of the Indus-Tsangpo Suture (Figure 1).

Future work

We are currently performing tomographic inversions for the region using these data. These results will offer resolution not available in our 1-D models. The 1-D results, with their simpler underlying assumptions, will provide a test of the tomography results.

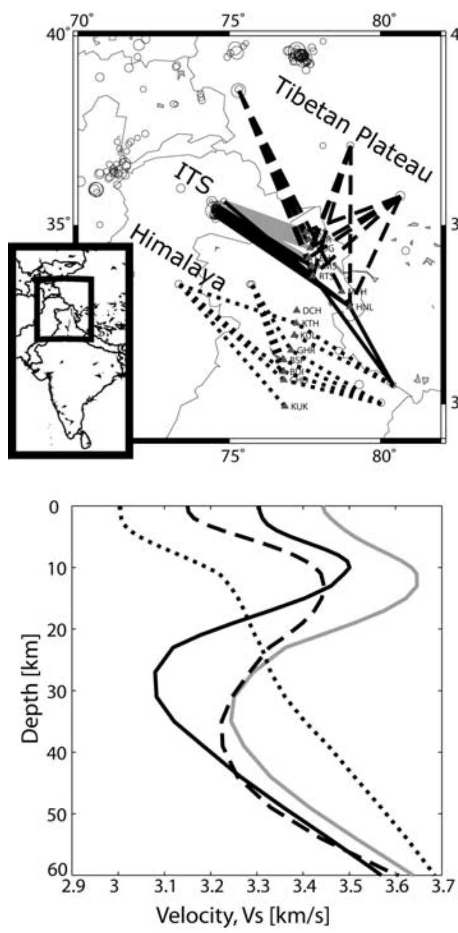

FIGURE 1. Upper: Locations of seismograph stations and epicenters of earthquakes scaled by magnitude (all magnitudes are between 3.8 and 6.4). Lines are earthquake paths used for this study. We designate 3 principal geologic regions: 'Tibetan Plateau,' 'Indus-Tsangpo Suture' (ITS), and 'Himalaya.' Lower: Mean of the shear wave velocity models in each regional group. Line styles follows the map. Event-station paths in the thrust and foreland basin (dotted lines) show a normal velocity profile that increases with depth. Event-station paths north of the ITS in the Gangdese Batholith (gray solid lines) show the highest velocity, and, along with paths from the Tibetan Plateau (dashed lines), have a low-velocity zone at 30–40 km. Event-station paths in the ITS (black solid lines) have a pronounced low-velocity zone at 25–30 km.

References

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Rai SS, K Priestley, VK Gaur, S Mitra, MP Singh and M Searle. 2006. Configuration of the Indian Moho beneath the NW Himalaya and Ladakh. *Geophysical Research Letters* 33 (L15308): doi:10.1029/2006GL026076.