The location of Indian lithosphere beneath Tibet: Insights from group and shear wave velocity structure

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Processes occurring in large, hot, orogenic settings are not yet well understood. From the seismic properties of the lithosphere in areas of active continental collision we can gain insights into deformation processes occurring in present-day orogenies and make inferences about ancient orogenies. Tibet is an excellent natural laboratory for investigating collisional processes: it is the largest and highest orogenic plateau on Earth today.

New dispersion curves, measured from region earthquakes received at stations in West Tibet, Pakistan, and Southern India, and those measured from ambient noise cross-correlations for networks in India and the whole of the Tibetan Plateau, are used together with older dispersion measurements to obtain new fundamental mode Rayleigh Wave group velocity maps for Tibet for periods from 5-70s. The dense path coverage at the shortest periods due to the inclusion of ambient noise data allows features of ~100km scale to be resolved. The group velocity variations seen in these maps correspond well with known geological and tectonic features. In particular there is a strong correlation between low velocity group velocity at short periods and areas of thick sediments.

The Rayleigh wave group velocity maps are used to invert for shear wave velocity profiles to a depth of 120km. A mid crustal low velocity layer (~10% decrease in velocity) is observed throughout much of Tibet, with the exception of the northern part of West Tibet. We attribute this to radiogenic heating of the crust. The transition from the crust to the mantle occurs at lower shear velocities in the eastern part of the plateau than in the western part. This cautions against the use of a velocity proxy for mapping out crustal thickness in this region, and suggests that there may be important differences between East and West Tibet. These differences are emphasized by the elevated velocities, similar to those beneath India and the Tarim Basin, observed west of 84^{o} at depths exceeding 90km, i.e. in the upper mantle, across the entirety of West Tibet. We interpret this as Indian lithosphere underthrusting all the way across the plateau in the west, but not in the east. These differences may be the result of difference in the composition of the leading edge of India prior to collision: potential pre-collisional differences in the composition of the lower plate along the length of the orogen have strongly influenced the deep crustal and upper mantle structures that developed in other, older orogenic belts.