Abstract

The Northeast India and surrounding regions are crucial to understand the plate dynamics of Indian-Eurasia continental collision. The region is significantly affected by the processes shaping the Himalayan orogeny and Burmese Arc, resulting in a complex geometry of the crust and lithospheric mantle. Despite numerous efforts, the subduction dynamics of the Indian plate beneath the Himalaya and Burmese arc regions remain enigmatic. Three-dimensional (3–D) seismic tomographic imaging techniques hold great potential to unravel the mysteries of deep earth by modelling the perturbations in travel time data compared to those predicted by existing standard models. However, the success of tomographic inversions is dependent on uniform data coverage. Earlier tomographic models produced for the northeast India region were of low resolution, primarily due to lack of data coverage. Taking advantage of newer datasets having much better coverage compared to earlier studies, highly refined 3–D tomographic models are produced for the Northeast Indian region.

Initially, 3–D body wave velocity perturbation maps of the upper mantle beneath Eastern Himalaya and Burmese subduction zones were obtained using teleseismic travel-time tomography. Analysis of waveforms of 5,727 teleseismic earthquakes (30–100°) with magnitudes $\geq$5.5 recorded at 273 seismic stations yielded an accurate data set of 86,570 P-arrival and 85,227 S–arrival times using the multichannel cross–correlation (MCC) technique. The 3–D velocity perturbations at $2^\circ \times 2^\circ$ lateral resolution are then produced by inverting the travel-time residuals. Images of the Earth's structure deep down to depths of 1,000 km gleaned from the tomograms reveal that the subducting Indian lithospheric plate extends up to the Bangong-Nujiang Suture Zone (BNSZ), overturns and descends steeply at depths greater than 200 km below the Himalayan arc. A southward plunging detached Indian

slab can be traced reaching depths greater than 600 km. Results do not show evidence for a detachment of a south-east deflecting Indian lithospheric slab below the Burmese arc. The geometry of the slab mimics regional seismicity (up to 200 km) followed by a deeper aseismic zone related to petrological changes. No gaps are seen between the northward and eastward subducting Indian plate, hence confining the eastward escape of Tibetan-lithospheric material between the Eastern Himalayan Syntaxis (EHS) and the Sichuan Basin.

Subsequently, a 3–D isotropic shear wave velocity tomographic image is produced up to ∼100 km depth. A non-linear damped least square method is used to invert the dispersion curves. The dispersion curves were extracted at each node point of the Rayleigh and Love wave surface wave group velocity U_g maps. The data is inverted using fundamental mode surface-wave group velocity tomography invoking the fast-marching method to produce shear wave velocity structure. In my thesis, I provide shear velocity structure of the crust and upper mantle beneath northeastern India and Tibetan plateau with $1^\circ \times 1^\circ$ resolution. Waveforms of surface waves of 568 local earthquakes recorded at 326 seismic stations throughout the study region were combined to create a U_g dataset for periods in the range of 4–100 s. Radial anisotropic maps across the study area produced by examining the disparity between vertically (V_{SV}) and horizontally (V_{SH}) polarized shear wave velocity measurements, show lateral differences within the crust. The observed variations in the velocity structure and radial anisotropy along with crustal thickness in the Tibetan plateau, supports the concept that the region serves as a pathway for eastward and south-eastward migration of material. Lower shear velocities in the Tethyan Himalayan upper crust (∼2.8 km/s), Lhasa middle crust (∼3.2 km/s) and lower crust in the Qiangtang and Songpan-Ganzi terrane (∼3.5 km/s) reflect channel flow directed outwards from the Tibetan plateau that flows southwards and southeastwards across the Lhasa terrane and rotation around the Eastern Himalayan Syntaxis respectively. The velocity structure also suggests possibility of accumulation of flow close to the southern Yunnan province at 26° N.

The thesis work provides high resolution body and surface wave tomography models covering northeast India and adjoining regions. Both models complement each other in resolving features of shallow and deep Earth. The near vertical incidence of the teleseismic rays makes it impossible to resolve features above 100 km depth in the teleseismic body wave tomography models produced for northeast India and Tibetan Plateau regions. Surface wave tomography models target unresolved shallow features that were missed by the body wave tomography models. Results from this study enable unravelling previously unresolved features and provide crucial inputs to my understanding of tectonics and geodynamics of the region.