Geophysical Research Abstracts
Vol. 20, EGU2018-941-1, 2018
EGU General Assembly 2018

Modeling the Hales discontinuity beneath the Indian subcontinent

Jashodhara Chaudhury and Supriyo Mitra
Indian Institute of Science Education and Research Kolkata, Earth Science, India (jashodhara359@gmail.com)

Hales discontinuity was first observed in Lake Superior, North America at a depth of 80-90 km. It was characterized by an increase in P-wave velocity from 8.05 to 8.45 km/s. Subsequent worldwide studies have observed this discontinuity beneath selective regions ranging in depth from 50 to 105 km. It was also revealed that tectonically active regions are characterized by shallow Hales discontinuity (eg. Northwestern Pacific subduction zone, Japan and Philippine sea), while those beneath stable cratons have greater depth (eg. Slave craton, Congo craton, Yangtze craton, Yilgarn craton, Kaapvaal craton, Arabian shield, Guiana shield, Baltic shield). The cause for the absence of observable signal corresponding to the Hales discontinuity beneath a number of seismic stations and the large depth variation of the discontinuity are poorly understood and warrants further investigation.

In the Indian subcontinent, the Hales discontinuity has been selectively imaged beneath seismic stations of the southern granulite terrain, eastern Dharwar craton, Bastar craton, Aravalli craton and the Vindhyan proterozoic basin. These studies have used P-wave receiver functions (P-RFs), computed at low frequency (low pass filtered at 0.2 Hz) to show that the Hales discontinuity corresponds to a Phs phase which arrives between 7.5 and 11 s. A few studies have forward modeled this phase using a crustal layer, a mantle layer and a half space, to demonstrate that this arrival is distinct from Moho reverberations and corresponds to a depth range of 75 to 90 km without considering any mid-crustal discontinuity. We demonstrate through forward modeling of P-RFs that the previously observed Hales discontinuity Phs can be matched by the PpPs (first positive reverberation) beneath GBA (Gauribidanur) and PpSs+PsPs (second negative reverberation) beneath KOD (Kodaikanal) from mid-crustal discontinuity with the exception of Hyderabad (HYB), where this discontinuity had been reported to be deepest at 90 km. We model high frequency P-RFs (Gw = 2.5, f_{max} = 0.46 Hz) from HYB to put additional constraints on the observed Hales discontinuity. Joint inversion of the HYB P-RFs with Rayleigh wave phase velocity dispersion data reveal Hales discontinuity at a depth of 108±4.5 km, with 2.8% increase in S-wave velocity (v_s) from 4.63 to 4.76 km/s. This joint inverted depth of the Hales discontinuity depends on the frequency content of the receiver functions. The depth of the Hales discontinuity corresponds to a particular P-T range given the PREM model and Indian shield geotherm for reference to pressure and temperature respectively. The modeled depth of Hales discontinuity beneath HYB (∼108 km), GBA (∼98 km), KOD (∼103 km) falls into the P-T range where spinel-garnet coexistence ends and only garnet peridotite starts to occur in bulk composition varying from fertile to depleted peridotite mantle. We further our study to the Canadian Shield to compare and contrast our results from the Indian subcontinent.