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Lithospheric Structure of the Himalaya Orogen in Bhutan

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The Bhutanese Himalaya lie within the eastern quarter of Himalayan orogeny which is the expression of ongoing collision between the Indian and Eurasian plates. The Cenozoic collision caused the detachment of the early Proterozoic through Paleocene sediments from the underlying basement into a series of large south-vergent thrust sheets, which forms the fold-thrust belt in the southern part of Bhutan. The geology of the study area is mostly dominated by the rocks of Greater Himalayan (GH) and Lesser Himalayan (LH). However, small portion of Sub Himalayan rocks and Tethyan Himalayan sequence are also seen in the central part of Bhutan. To investigate the crustal structure beneath western, central and eastern Bhutan, a detailed gravity survey was conducted along the all major roads in 2015-2019. Approximately, 5300 gravity stations, with the station interval ranging between 0.5 and 1 km were acquired using L&R model G gravimeter and differential GPS methods. The gravity stations were tied to the absolute gravity station at the office of National Land Commission in Thimphu, Bhutan. The data were computed into Complete Bouguer gravity anomalies using 2.67 g/cc as reduction density and available 10 meter DEMs for terrain corrections.
The data were analyzed using map methods (Euler deconvolution and wavelength filtering) which clearly indicates the significant along east-west strike variations in the crustal structure. Five 2-D gravity models across the tectonostratigraphic units were constructed to
determine the crustal structure using constraints from the recent seismic receiver function and ambient noise studies, and balanced cross sections using surface structural data. The results support the long wavelength anomalies are associated with the variation of Moho depth that are caused by the flexure of Indian plate beneath Bhutan Himalaya. The modelling shows the Moho depths increases towards the north from 50 km beneath Main Frontal Thrust to 75 km beneath the GH sequence. The modelling also provide constrains on the high resolution geometries and extends of different geologic units including the Lesser Himalayan duplex beneath GH units that exposed as tectonic window (Paro Formation) and major tectonic structures like
Main Boundary Thrust, Main Central Thrust and the Shumar Thrust. The combination of forward modeling and map analysis helps deciphering the lithospheric structures beneath Bhutan.