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Gravity and Flexure Modelling of Subducting Plates

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The long-term strength of the lithosphere is determined by its flexural rigidity, which is commonly expressed through the effective elastic thickness, T_e. Flexure studies have revealed a dependence of T_e on thermal age. In the oceans, loads formed on young (<70 Ma) seafloor have lower T_e than loads formed on old (>70 Ma) seafloor. In the continents, loads on young (<500 Ma) lithosphere have lower values than loads on old (>1000 Ma) lithosphere. Recent studies have questioned the relationship of T_e with age, especially at subduction zones, where oceanic and continental lithosphere are flexed downwards by up to ∼6 km over horizontal distances of up to ∼350 km. We have therefore used free-air gravity anomaly and topography profile data, combined with forward and inverse modelling techniques, to re-assess T_e in these settings. Preliminary inverse modelling results from the Tonga-Kermadec Trench – Outer Rise system, where the Pacific plate is subducting beneath the Indo-Australian plate, show large spatial variations in T_e that are unrelated to age. In contrast to the southern end of the system, where T_e is determined by the depth to the 600˚C and 900˚C isotherms, the northern end of the system shows a reduction in strength. Results also suggest a reduction in T_e trenchward of the outer rise that is coincident with a region of pervasive extensional faulting visible in swath bathymetry data. In a continental setting, the Ganges foreland basin has formed by flexure of the Indo-Australian plate in front of the migrating loads of the Himalaya. Preliminary forward modelling results, using the Himalaya as a known surface topographic load, suggest that T_e is high – consistent with the great age of Indian cratonic lithosphere. However, results from inverse modelling that solves for unknown loads (vertical shear force and bending moment) show significant scatter and display trade-offs between T_e and these driving loads.