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Plate flexure and the evolution of foreland basins

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Foreland basins form by flexure in front of migrating fold and thrust loads. By comparing the observed Bouguer gravity anomaly and depth to the base of the foreland basin sequence to predictions based on simple elastic and viscoelastic plate models, we have learnt a considerable amount about the physical properties of the lithosphere and its control on structural styles in fold and thrust belts and the stratigraphic development of their flanking foreland basins. Results show that foreland basin flexure is caused by both surface (topographic) and sub-surface (i.e. buried) loads and that the effective elastic thickness of the lithosphere, T_e, that responds to these loads ranges from low to high values. The wide range of T_e can be explained if fold and thrust loads are able to migrate across weak stretched crust and onto strong unstretched craton, as is predicted to occur during the orogenic stage of the Wilson Cycle. Yield Strength Envelope considerations suggest that stretched crust is weak because of high geothermal gradients, rapid stress relaxation and high fluid content while cratons are strong because of low geothermal gradients, slow stress relaxation and low fluid content. Depending on the nature of fold and thrust load encroachment, T_e may vary spatially and, because of structural inheritance, influence tectonic styles (e.g. thin skin Vs. thick skin) in the orogen and basement 'architecture' (e.g. promontories Vs. embayments) and river drainage patterns (e.g. latitudinal Vs. longitudinal) in the foreland. Some foreland features, however, cannot be explained by flexure and require contributions from other processes such as mantle dynamics in order to explain them. The association of foreland basins, however, with plate boundaries makes separating plate mechanics and mantle dynamics a difficult problem.