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Large-Wavelength Post-Orogenic Exhumation of the Canadian Cordillera Foreland Belt and Basin: Interplay between Lithospheric Rheology and Mantle Geodynamics

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The SE Canadian Cordilleran foreland belt and basin yield remarkable post orogenic exhumation with an amplitude of several kms and a wavelength in the range of 1000 km. Overburden studies indicate that 4-6 km of sediments in the foreland belt remained conserved from syn-orogenic local tectonic exhumations, and were exhumed only in post Laramide times together with 3 km of sediments from the basin. This large wavelength exhumation occurred after contraction had ceased at this eastern retro-wedge of the Canadian Cordilleran system in Paleocene times. These observations suggest epi-orogenic (intraplate) vertical motions motions of the region–possibly dynamic topography in response to viscous stresses exerted at the base of the lithosphere by underlying mantle flow. Elaborate geophysical probing reveals that the foreland belt marks a transition zone where many crustal and upper mantle geophysical parameters change from the Cordillera eastward into the stable North American Craton. In particular, significant thinning of the lithosphere has been documented from elevated surface heat-flow data.

This study uses geodynamic modeling to consider the response of a heterogeneous lithosphere to sub-lithospheric mantle flow and test whether that could explain the observed exhumation and inferred long-wavelength uplift.

The spatial variability in modelled lithospheric strength and temperature is based on geophysical constraints on the SE Cordilleran and cratonic compositional and thermal structure. Velocity boundary conditions are used to simulate various regimes of mantle flow, presumed to be related to on-going slab subduction further to the west. The response of the lithosphere–i.e., amplitude and wavelength of the surface motions–is controlled by the interplay of the sub-lithospheric mantle flow and the deduced rheological/thermal transition between the belt and craton. Depending on the timing and mechanism, combining mantle flow modeling with a heterogeneous lithosphere might help link the observed large wavelength uplift and thermal attenuation.