

Evidence of active mantle flow driving surface motions in Alaska

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Although it is widely agreed that coupling between oceanic lithosphere and the convecting mantle plays an important role in driving rigid plate motions and generating observed deformation at localized plate boundaries, observations of deformation driven by gradients in tractions applied at the base of the lithosphere in intraplate have not been identified. The plate boundary between the North American and Pacific plates in Alaska is unlike any other continental convergent margin. The 5.5 cm/yr of convergence is accommodated within an abnormally narrow 500 km zone in southern Alaska; inboard, the measured surface velocities indicate anomalous extension that is parallel to the convergence direction. Here we use the surface deformation field constrained by GPS, together with a geodynamic model, to show that tractions generated by mantle convection drive continental lithospheric deformation within interior Alaska generating a southward directed surface motions toward the southern convergent plate boundary. This traction field (~2-5 MPa) in northern and interior Alaska: (1) drives extension and surface motions not associated with any plate boundary, a characteristic that is globally singular; (2) may balance forces generated by Pacific plate subduction, limiting the zone of plate motion accommodation; (3) generates the observed convergence far within the North American plate interior in the Mackenzie mountains in northwestern Canada. These results have important implications for geophysicists and geologists who work on convergent margin processes, as well as those who work on continental tectonics and mantle dynamics in general, because of the anomalous kinematic observations within this convergent zone and the first direct evidence of the deeper mantle influencing surface deformation beneath a continent.

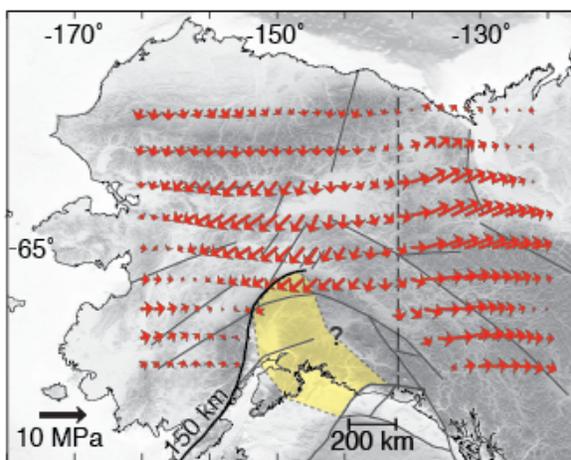


Figure: The calculated forces imposed on the base of the lithosphere that are associated with plate coupling with mantle convection. Forces are plotted within the interior of the grid where the model is robust and void of boundary effects. Dark line denotes the 150 km depth contour of the Pacific plate and yellow zone indicates the approximate location of the shallowly subducting Yakutat microplate that appears to redirect south-directed mantle flow to the east and west generating convergence in the Mackenzie mountain region. MM – Mackenzie Mountains.