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Using a Geodetic Strain Rate Model for the Western United States to Improve our Understanding of the Driving Forces in Continental Extension Zones

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The past and present-day deformation fields in the northern Basin and Range Province (BR) have variably been explained to be the result of 1) far-field forces due to plate motions; 2) internal gravitational potential energy (GPE) variations in the lithosphere; 3) basal drag and/or mantle upwelling; or a combination of these factors. Particularly, stresses resulting from GPE differences (due to lithospheric and mantle density variations) have been invoked in many studies to explain all or most of the extensional deformation. One aspect that most studies have failed to address is that observed extensional stress and strain rate directions in the central BR are at a high angle with gradients in GPE as derived from geoid models. Moreover, several lines of evidence suggest the presence of a weak lower crust and concurrent lower crustal flow beneath the BR which could imply decoupling between the brittle crust and lithospheric mantle.

We investigate whether the surface strain rate field (modeled from an interpolation of geodetic velocities) provides clues about the relative importance of plate boundary vs. gravity-driven motions. In particular, we evaluate extension directions and the balance of dilatation in the western U.S. interior from the strain rate model, and asses the de-correlation between these components of the surface deformation field with GPE inferred stress fields. Deformation expected from GPE variations is poloidal (creating or destroying area). However, if the integrated strain rate over the entire plate boundary yields non-zero dilatation, it could be argued that deformation is driven by divergence of the Pacific Ocean from North America. If, on the other hand, net dilatation is zero, it could be argued that, either the origin of the GPE-driven dilation is

more local/regional, resulting in gravitational highs and lows that balance the expected shortening and extension on a regional scale, and net deformation is consistent with PA-NA transform motion.