Postseismic Displacements From PBO Sites Near The Denali Fault

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Large earthquakes offer rare opportunities to measure the response of the lithosphere and mantle to a sudden stress change; we must take full advantage of these opportunities to learn about the mechanical properties of Earth and move beyond kinematic descriptions of active tectonic processes.

Postseismic displacements from PBO sites near the Denali fault (Figure 1) show a spatial and temporal evolution that cannot be explained by any single postseismic deformation mechanism [Freed et al., 2006a]. Far-field sites are dominated by deformation from power-law viscoelastic flow in the mantle, consistent with laboratory measurements of olivine rheology [Freed et al., 2006b]. Near-field sites show a significant contribution from afterslip (or possibly localized viscoelastic shear in the lower crust), and a small contribution from poroelastic rebound. While the need to include multiple deformation mechanisms in a successful model now seems clear, the relative contributions of the different mechanisms is less certain, and some important mechanical details remain in dispute. For example, Pollitz [2005] argued for a transient rheology for the mantle rather than a power-law rheology.

More work needs to be done on postseismic deformation models, and this work will require years of additional data. As seen in Figure 1, the optimal model is not yet fully constrained by the data. Models that fit the earliest data do not necessarily match the end of the time series, so additional data will be required to narrow down the range of possible mechanical models for the Alaskan lithosphere and mantle.

In addition, all present models fit the vertical data poorly (not shown). Vertical displacements include a strong seasonal component, which can only be eliminated by careful modeling based on several years of data.

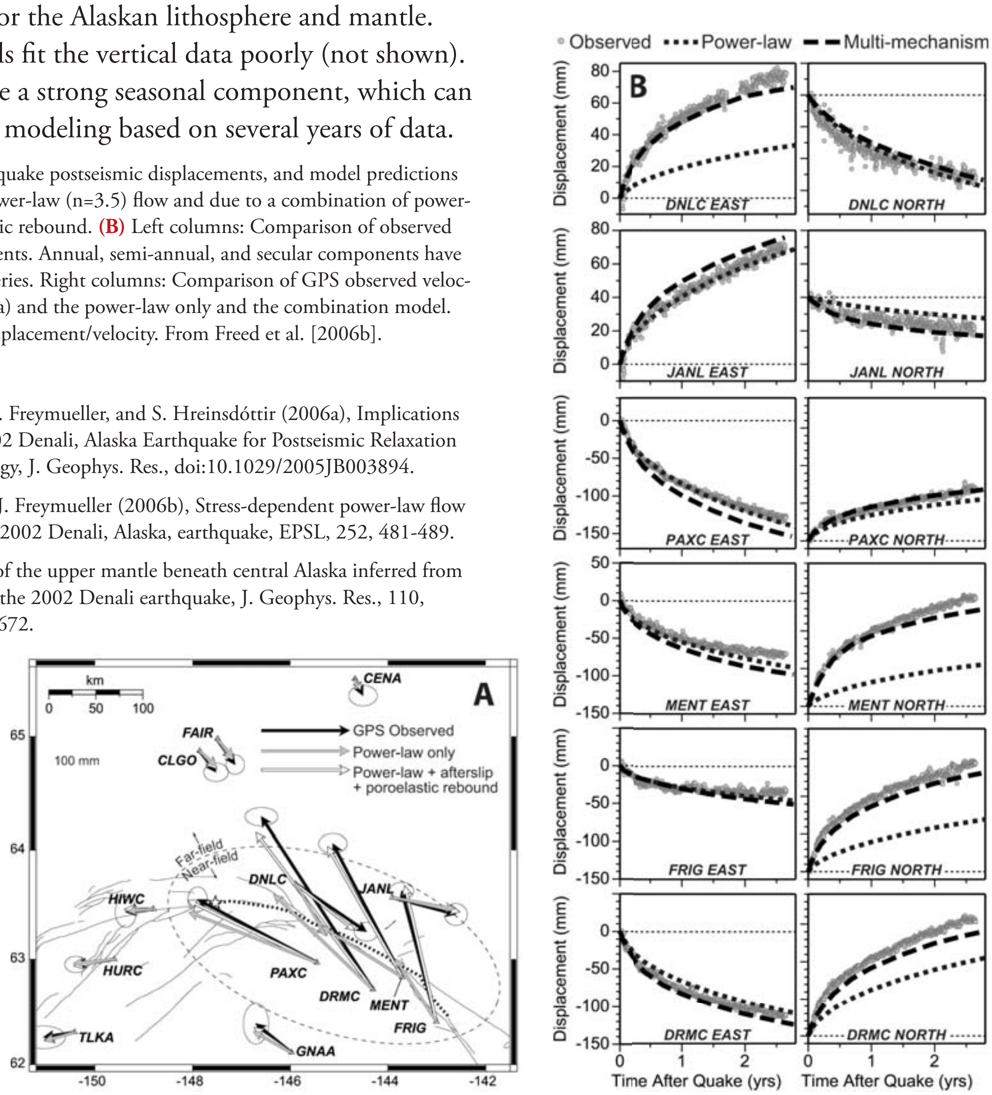

Figure 1. (A) Map view of Denali earthquake postseismic displacements, and model predictions calculated by viscoelastic flow due to power-law (n=3.5) flow and due to a combination of power-law flow, shallow afterslip, and poroelastic rebound. **(B)** Left columns: Comparison of observed GPS position time-series and displacements. Annual, semi-annual, and secular components have been removed from the observed time series. Right columns: Comparison of GPS observed velocity (based on a logarithmic fit to the data) and the power-law only and the combination model. Horizontal dashed lines indicate zero displacement/velocity. From Freed et al. [2006b].

References

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