The earthquake cycle on the Denali fault, Alaska, and its implications for the study of great earthquakes in Asia

Jeffrey T. Freymueller[1], Yan Hu[2]

1) Geophysical Institute, University of Alaska Fairbanks

2) University of Science and Technology of China, Hefei

We have measured and modeled 15 years of postseismic deformation following the 2002 Denali fault earthquake in central Alaska, in order to constrain the mechanical properties of the lithosphere and asthenosphere and better understand the earthquake cycle. We use data from ~100 continuous and episodic GPS sites surrounding the 325 km long rupture of the Denali fault. Post-earthquake data span the period 2002-2017, and we resampled the time series to a series of uniform intervals for modeling. We have developed a 3D finite element model to describe the postseismic deformation. We compare models that include viscoelastic relaxation only, along with models that include stress-driven afterslip. A key point in the latter models is that it is critical to allow afterslip only within the depth range at which it actually occurs, as there is no evidence for shallow afterslip despite variations in the coseismic slip at shallow depths. We find that the afterslip component decays more rapidly in time than the viscoelastic component of postseismic deformation, consistent with other studies. Using models that explain the later-stage postseismic deformation to constrain the viscosity structure, we then reconstruct the earlier time decay of the postseismic signal. The viscosities we obtain here require relaxation times of a few decades, with an additional shorter-term transient component. Postseismic deformation remains a significant more than a decade after the earthquake, and at distances of a few hundred km away. Earlier studies of the 1906 San Francisco earthquake showed similar results, and the same can be expected for large earthquakes in China, including Wenchuan and Kokoxili. As a result, the postseismic signals will bias or mask other tectonic signals if not correctly removed.