Using GPS to Unravel the Tectonics of Interior Alaska

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Geologic maps of interior Alaska show a high occurrence of faulting. Information about these faults has up to now been based mainly on geological observations in the field. Seismicity maps give us some information on the location and activity of certain faults, but the density of seismic sites is far from ideal. The most obvious tectonic feature in the interior of Alaska is the Denali fault, which is visible on satellite maps as a geomorphic feature extending in a broad arc for more than 2000 km. Slip rates of 8-12 mm/yr are estimated for the Denali fault based on offset Pleistocene glacial features to the east of Mt. McKinley. However, previous geodetic measurements of slip rate along the Denali fault produced results that appeared to show a much smaller rate of right lateral shear. Another major tectonic feature in Alaska is the Tintina fault, a large right lateral fault system 250km to the north of the Denali fault. The pattern of seismicity in the region between these two fault systems shows NE-SW lineations, which have been interpreted as edges of elongate crustal blocks.

Since 1995 we have been making GPS observations in this region, with the goal of using deformation information as another tool to understand the present-day tectonics. Our observation network consists of 55 GPS sites in interior Alaska, the majority of which have been measured at least four times. We find that sites within about 50 km of Fairbanks show no significant motion with respect to Fairbanks, indicating a low rate of strain accumulation for this region which spans three NE-SW seismic lineations between the Denali and Tintina faults. Sites further south have velocities consistent with right-lateral slip on the Denali fault. We construct a model combining counter-clockwise rotation of the block south of the Denali fault with elastic strain accumulation on the fault. Using this model, the data require a slip rate of 7-11 mm/yr on the Denali fault or distributed on faults within 30km of the Denali fault.