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Westward decrease in the post-glacial slip-rate of the Denali fault, Alaska

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The right-lateral strike-slip Denali fault delimits the arcuate northern plate boundary between the North American plate and the Pacific plate. Two end models can be proposed to characterize the intracontinental deformation of southern Alaska with very different implications on the slip-rate of the Denali fault and the Alaska ranges. The arcuate shape of the fault implies that if the slip-rate on the Denali fault remains constant along strike, it would be consistent with a kinematic model in which the southern Alaska block (the Wrangell block) is essentially rotated counter-clockwise. On the other-hand, a slip-rate, that varies along strike, favors a model with a north-westward translation of the Wrangell block with respect to the North American plate without rotation. It also implies that convergence rates across the Alaska Range's northern frontal thrust fault system increases from east to west as the rate on the Denali fault decreases.
To test these models, we have determined the long-term slip-rate of the Denali fault using ^{10}Be cosmogenic surface exposure dating of offset glacial moraines at two sites (235 km apart). The model ages were corrected for the effects of snow shielding using historical snow cover data averaged over 30 years near our sites. Furthermore, to integrate the variation of snow cover over time, we included the relative changes in effective wetness over the last 11 ka, derived from lake-level records and $\delta^{18}O$ variations from two lakes north of the Alaska ranges. The moraine model ages are normally distributed with an average of 12.1$\pm$0.9 ka ($\pm 1\sigma$) and appear to be coeval

with the Younger Dryas cooling chronozone (12.9 - 11.6 ka). Thus, as both moraines were emplaced synchronously, our estimates of the slip-rate of the Denali fault relies only upon the measured offsets at both sites, regardless of any potential systematic uncertainty in the model ages.

Our results indicate that the Holocene slip-rate on the Denali fault decreases westward from 11.9±2.4 mm/yr at 144°W to 6.7±1.2 mm/yr at 149°W. These new data are consistent with a kinematic model in which the Wrangell block is essentially translating northwestward at a rate of ≈ 12 mm/yr relative to the North American plate. This also implies an increase of the active fold and thrust belt convergence rate from about 2 mm/yr to 10 mm/yr between 149 and 144°W.