GPS Velocities and Strain Accumulation in the Kamchatka-Aleutian Cusp

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The western Aleutian subduction zone (WASZ) is characterized by a rapid oblique motion of the Pacific plate (PAC) with respect to the North American plate (NAM) in the northwest direction. The Aleutian trench terminates to the southeast of Cape Kamchatsky, where the Aleutian and Kamchatka trenches make a cusp. The whole 2,200-km Aleutian megathrust demonstrates a rapid change in the sense of a relative motion between the Pacific and North American plates, from nearly trench normal at Alaska to nearly trench parallel at Kamchatka. This change is accompanied by an increase in the relative plate velocity from 61 to 76 mm/yr (an estimate based on our global GPS solution). Azimuths of the earthquake slip vectors for thrust earthquakes along the arc support an idea of strain partitioning, i.e., the motion in seismic ruptures tends to be less oblique than the plate motion [McCaffrey, 1992]. The strain partitioning predicts a steady westward motion of slivers of the hanging wall along strike-slip faults, resulting in an active collision of the far western Aleutian arc with Kamchatka [Geist and Scholl, 1994].

We show, using the constrained nonlinear inversion, that the high GPS velocity of Bering Island (WASZ) can be alternatively explained by the elastic strain accumulation resulting from locking at the subduction interface. In this scenario, there is no steady westward drift of arc slivers because the elastic strain is periodically released in earthquakes, with the islands returning to their original positions. Moreover, this approach allows us to explain specific azimuths and values of GPS velocities in Kamchatka at the cusp by superposed elastic strains, as compared with inversion by distributed slip within Kamchatka subduction zone only [Buergmann et al, 2005]. The subdued topography of the East Kamchatka Ridge near Cape Kamchatskiy is probably an additional evidence in favor of the extension of the Aleutian trench beneath Kamchatka. Unless longer time series at larger number of islands are observed, a unique interpretation of GPS velocities of the Aleutians is not possible [Apel et al., 2006]. Recently, the first epoch of GPS at Medny (Copper) Island was carried out, 100 km from Bering Island and at greater distance from the Aleutian Trench. Comparison of GPS velocities at Bering and Medny islands should provide evidence on how significant is the strain partitioning.

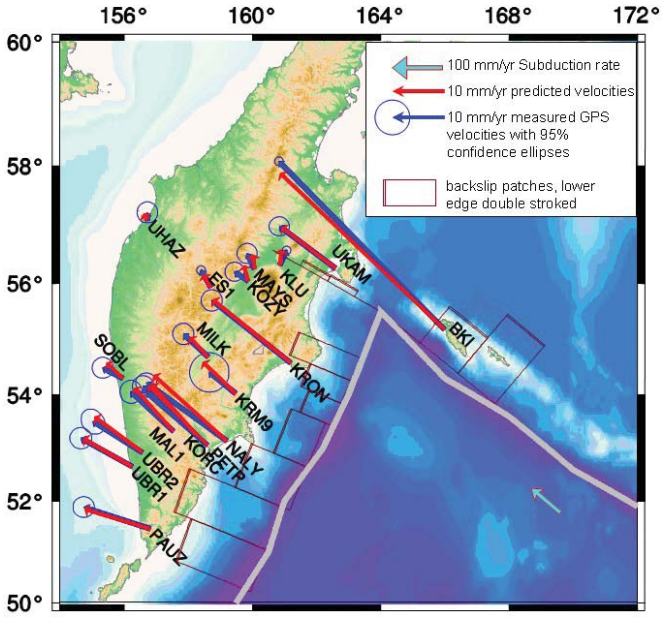

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Figure 1. Observed (GPS) and predicted horizontal velocities in the region of the Aleutian-Kamchatka cusp for the elastic dislocation model with multiple rectangular patches. Dislocations were modeled by a nonlinear least squares inversion of the observed velocities.