Geophysical Research Abstracts,
Vol. 11, EGU2009-1735, 2009
EGU General Assembly 2009

Earthquake cycle deformation landward and seaward of the megathrust seismogenic zone

K Wang

Geological Survey of Canada, Pacific Geoscience Centre, Sidney, BC, Canada (kwang@nrcan.gc.ca, 1-250-363-6565)

Earthquake-cycle deformation landward of the megathrust seismogenic zone is delineated mainly by land-based geodetic and seismic observations and modeled using fault slip and viscoelastic stress relaxation models. Coseismic and immediate post-seismic deformation is characterized by a seaward motion of the coastal area, with the size and rate of the displacement rapidly decreasing landward, as is currently observed at Sumatra where a M 9.2 earthquake occurred in 2004. Deformation a few decades after a giant earthquake shows a pattern of opposing motion, with the coastal area moving landward but the arc-back arc area continuing to move seaward, as is currently observed at Chile and Alaska where M > 9 earthquakes occurred in 1960 and 1964, respectively. Centuries after a giant event (or years to decades after a small event), all the land area moves landward with the rate decreasing landward, as is currently observed at Cascadia where a M 9 event occurred in 1700. The direction and speed of the land motion and their change with time yield critical information on the locking state of the megathrust and the rheology of the earth.

Earthquake-cycle deformation seaward of the megathrust seismogenic zone is technically more difficult to constrain because the area is offshore. Limited near-field monitoring and analyses of seismic waveforms indicate that coseismic rupture tends to peak at greater than 5-10 km depths and taper towards the trench, reflecting a coseismic strengthening behaviour of the shallowest part of the megathrust updip of the seismogenic zone. This strengthening behaviour not only has tremendous implications to tsunamigenic seafloor deformation and splay faulting, but also long-term deformation of the overlying forearc wedge. Repeated coseismic compression over numerous earthquake cycles may be responsible for the morphology and structure of the outer wedge, a process addressed by the dynamic Coulomb wedge model. Depending on the nature of the incoming plate and amount of trench sediment, the coseismic compression may lead to either wedge growth or basal erosion. The coseismically strengthened shallowest portion of the fault must relax after the earthquake, but the mode and timescale of the relaxation, as well as the interseismic stress evolution of the updip end of the seismogenic zone, have not been observationally constrained.