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Large early afterslip following the 1995/10/09 Mw 8 Jalisco, Mexico earthquake

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The behaviour of slip close to the trench during earthquakes is not well understood, with some earthquakes breaking only the near trench area, most earthquakes breaking only the deeper part of the fault interface, whereas a few break both simultaneously. Observations of multiple earthquakes breaking different down dip segments of the same subduction segment are rare.

The 1995 Mw 8 Jalisco earthquake, seems to have broken the near trench area, as evidenced by anomalously small accelerations for its size, the excitation of a tsunami, a small Ms relative to Mw and a small ratio between the radiated energy and moment (Pacheco et al 1997). However, slip models obtained using GPS campaign data, indicate slip near shore (Melbourne et al 1997, Hutton et al 2001).

We invert tele seismic P- and S-waves, Rayleigh and Love waves, as well as the static offsets measured by campaign GPS models, to obtain the slip distribution on the fault as a function of time, during the earthquake. We confirm that the slip models obtained using only seismic data are most consistent with slip near the trench, whereas those obtained using only GPS data are consistent with slip closer to the coast. We find remarkable similarity with models of other researchers (Hutton et al 2001, Mendoza et al 1999) using the same datasets, even though the slip distributions from each dataset are almost complementary. To resolve this inconsistency we jointly invert the datasets. However, we find that the joint inversions do not produce adequate fits to both seismic and GPS data. Furthermore, we model tsunami observations on the coast, to constrain further the plausible slip models.

Assuming that the discrepancy stems from slip that occurred within the time window between the campaign GPS measurements, but not during the earthquake, we model the residual displacements by very localised slip on the interface down dip from the coseismic slip. Aftershocks (Pacheco et al 1997) align on mostly between the non-seismic and co-seismic slip areas. As significant afterslip was observed in the months and years after the earthquake, we find it more likely that the non-seismic slip occurred after the earthquake, although we cannot exclude that it occurred during a slow slip event in the six months before the event. The total moment of the non seismic slip event is 16% of the earthquake, whereas the maximum afterslip was 1.2 meters during the 6 months before/10 days after the event, compared to just below 4 meters during the earthquake.

There are some unexpected observations; 1) our best fit rupture velocity for this event is 2.5 km/s, which is more similar to that of a typical subduction event than events on the shallowest part of the fault interface, 2) it is possible that the non-seismic slip occurred on a part of the fault plane that ruptured seismically in the June 3rd, 1932 Mw 8.2 earthquake.