The Postseismic Deformation Associated with the 2010 Mw 8.8 Maule, Chile Earthquake: A "Mirror" of the Nias Case?

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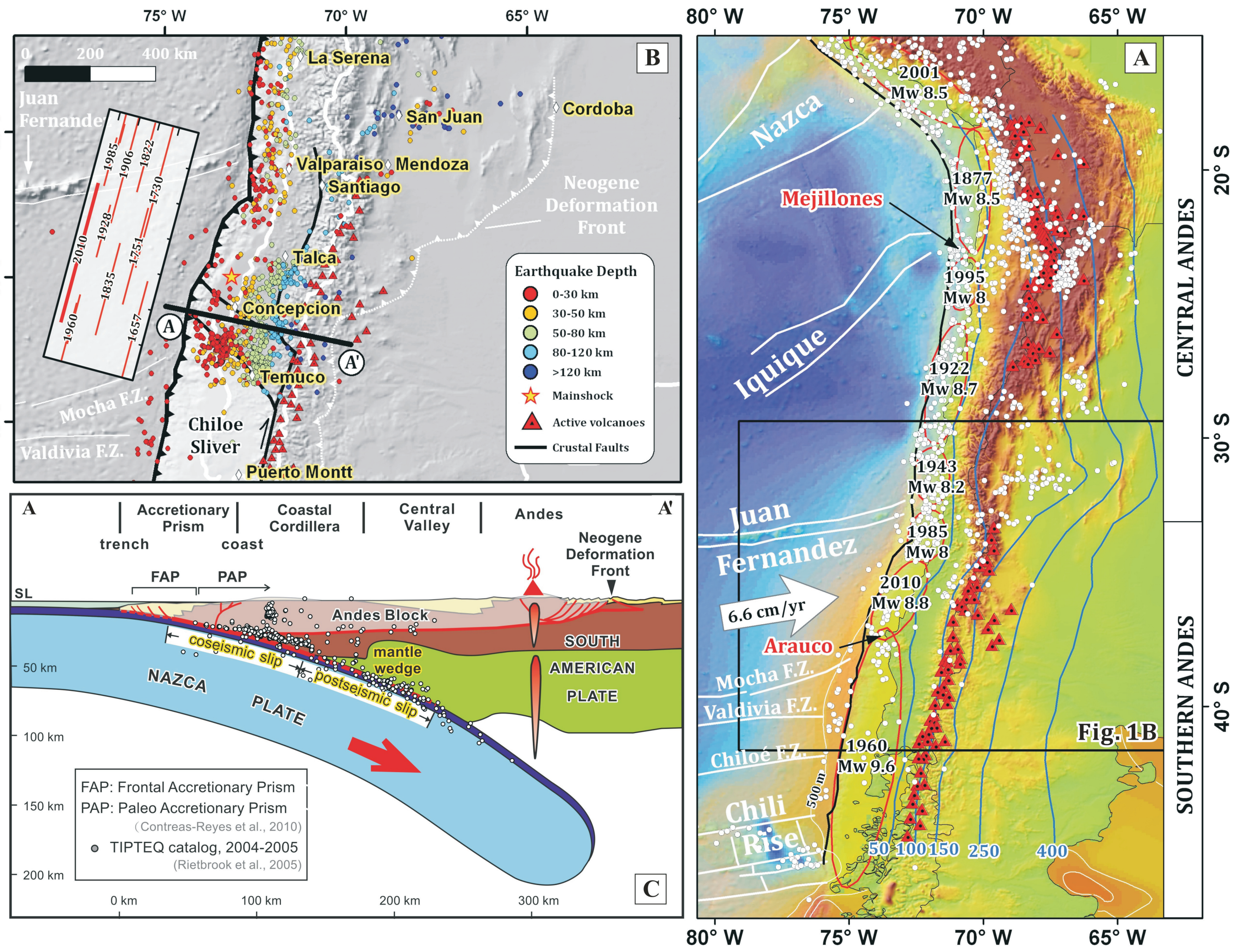
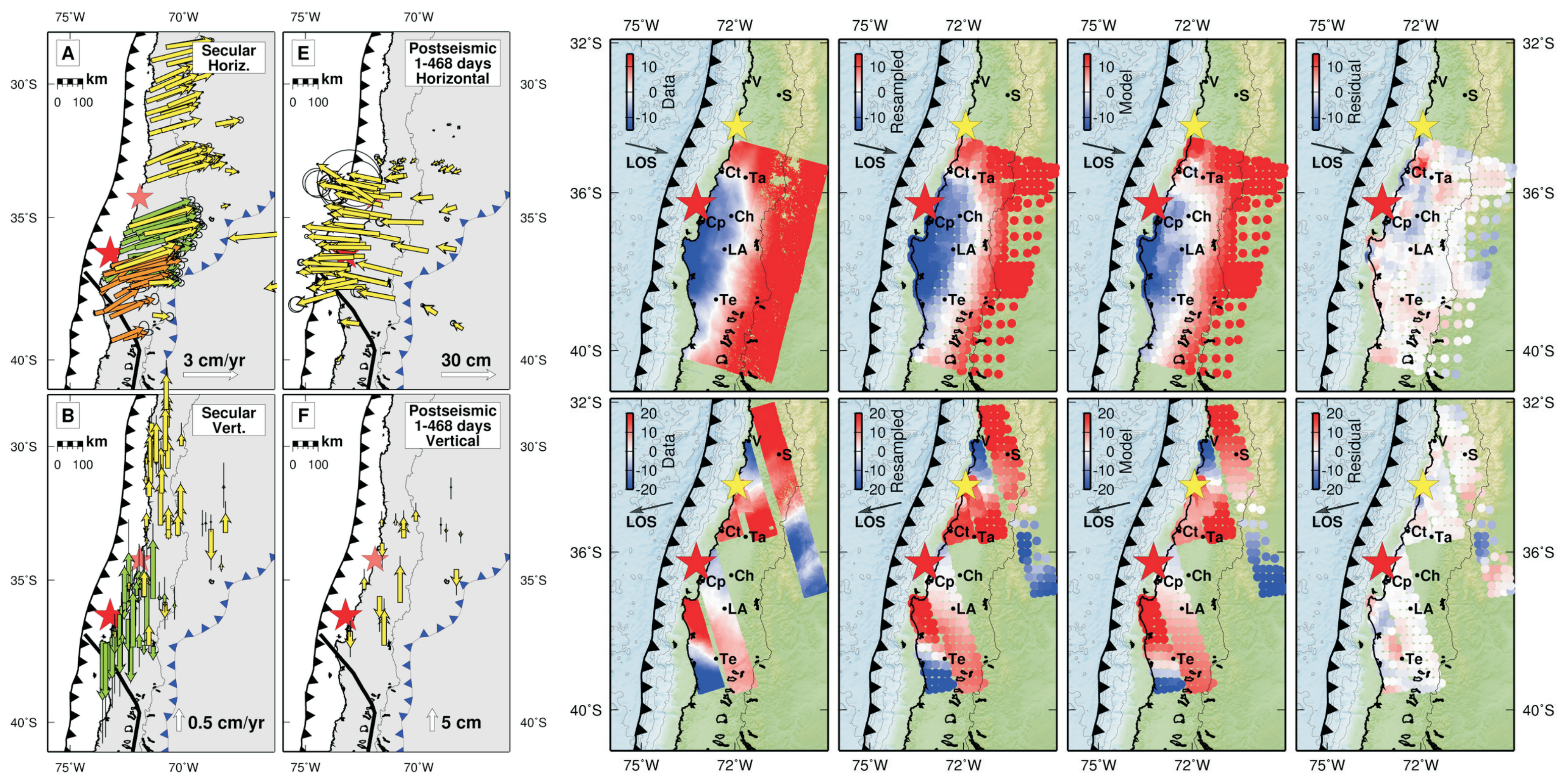
SEISMOTECTONIC & GEOLOGICAL SETTINGS



The 2010 Mw 8.8 Maule earthquake ruptured the megathrust segment right to the north of the patch associated with the 1960 Mw 9.5 Valdivia earthquake. Historic earthquake records indicate a clear seismic gap prior to the Maule earthquake (Campos et al., 2002), and pre-seismic secular GPS rates suggest a highly coupled patch along this gap (Ruegg et al., 2009; Moreno et al., 2010).

The Quaternary uplift rate in the forearc is low except at where peninsula develops, such as the Mejillones Peninsula and the Arauco Peninsula (Melnick et al., 2009; Victor et al., 2011). The loci of peninsular development correlate with upper crust structures. The backarc region still experiences active magmatism (Darwin, 1851) as well as Neogene compressional deformation (Folguera et al., 2004; Armijo et al., 2010). The relationship between the activity in the forearc/backarc structures and the earthquakes on the megathust remain poorly understood.

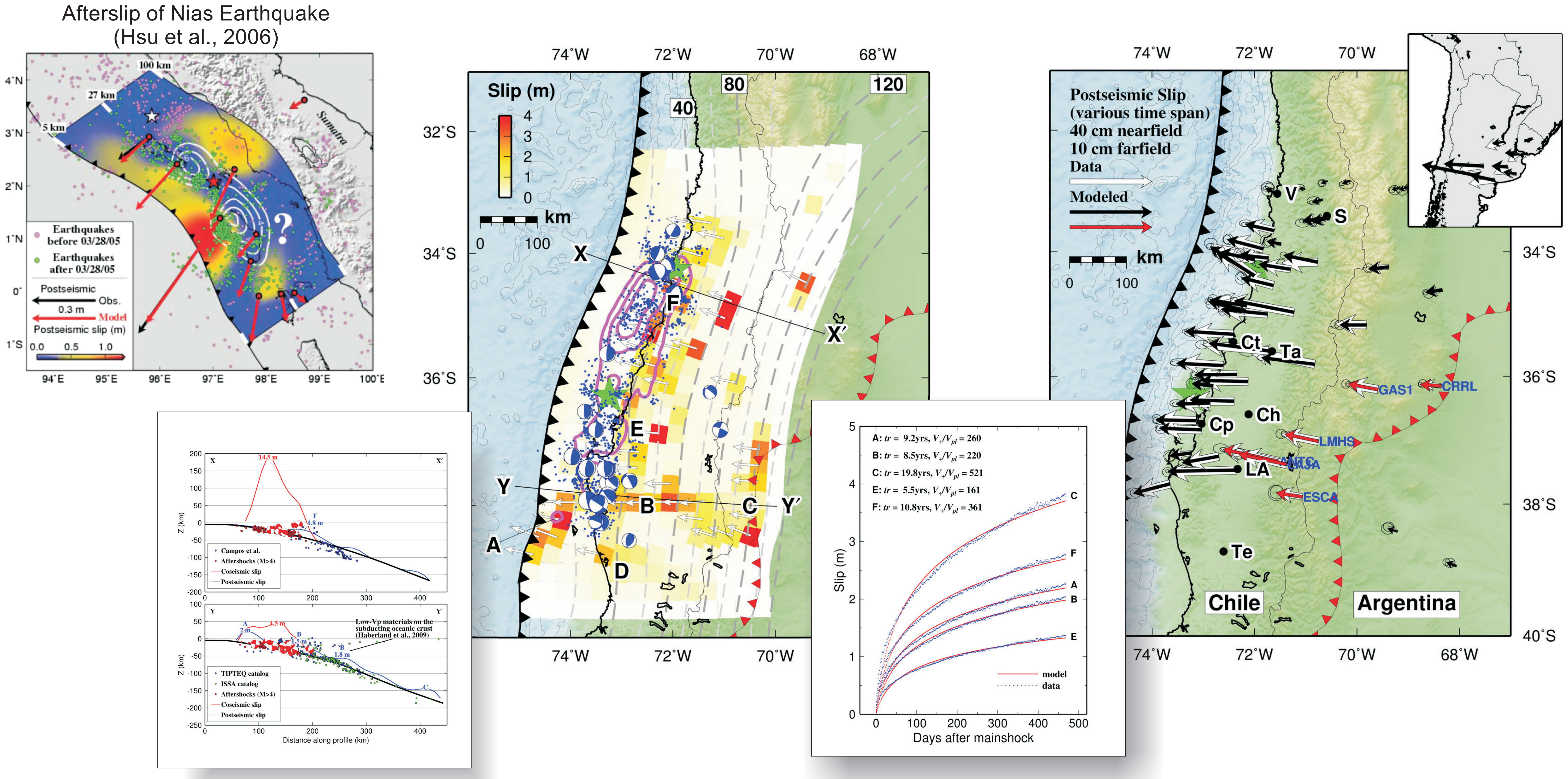
GPS & InSAR OBSERVATIONS



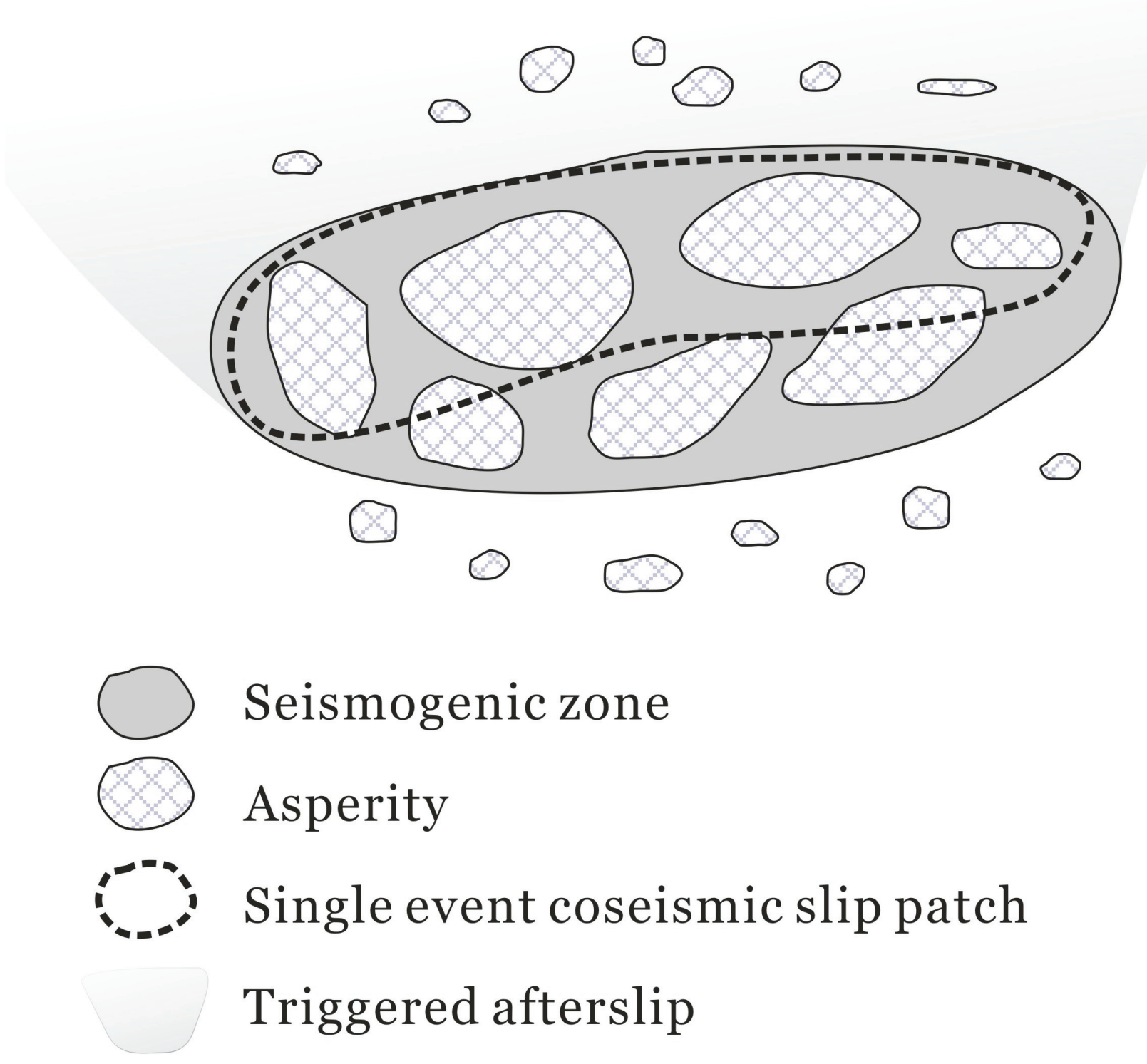
We process all GPS data by linearly fitting the time series with secular rates, seasonal variations, coseismic jump and post-seismic creep. Whenever the time series covers no pre-seismic periods, we interpolate the secular rates by using both derived and published rates (Moreno et al., 2008; Ruegg et al., 2009), and subtract the linear trends from the data. All stations are processed into a common stable South American reference frame.

We process all ALOS SAR images acquired between February and the end of 2010 by using ROI_PAC (Rosen et al., 2004). We include all interferograms of adequate coherence into our inverse model. The interferograms made from descending track 422 (wide swath) acquired between the 3rd and 48th day after mainshock form the most continuous map of the deformation field. These InSAR data provide significant spatial constraint to the afterslip pattern on the megathrust.

AFTERSLIP OF MAULE EARTHQAUKE: A "MIRROR" of NIAS CASE?

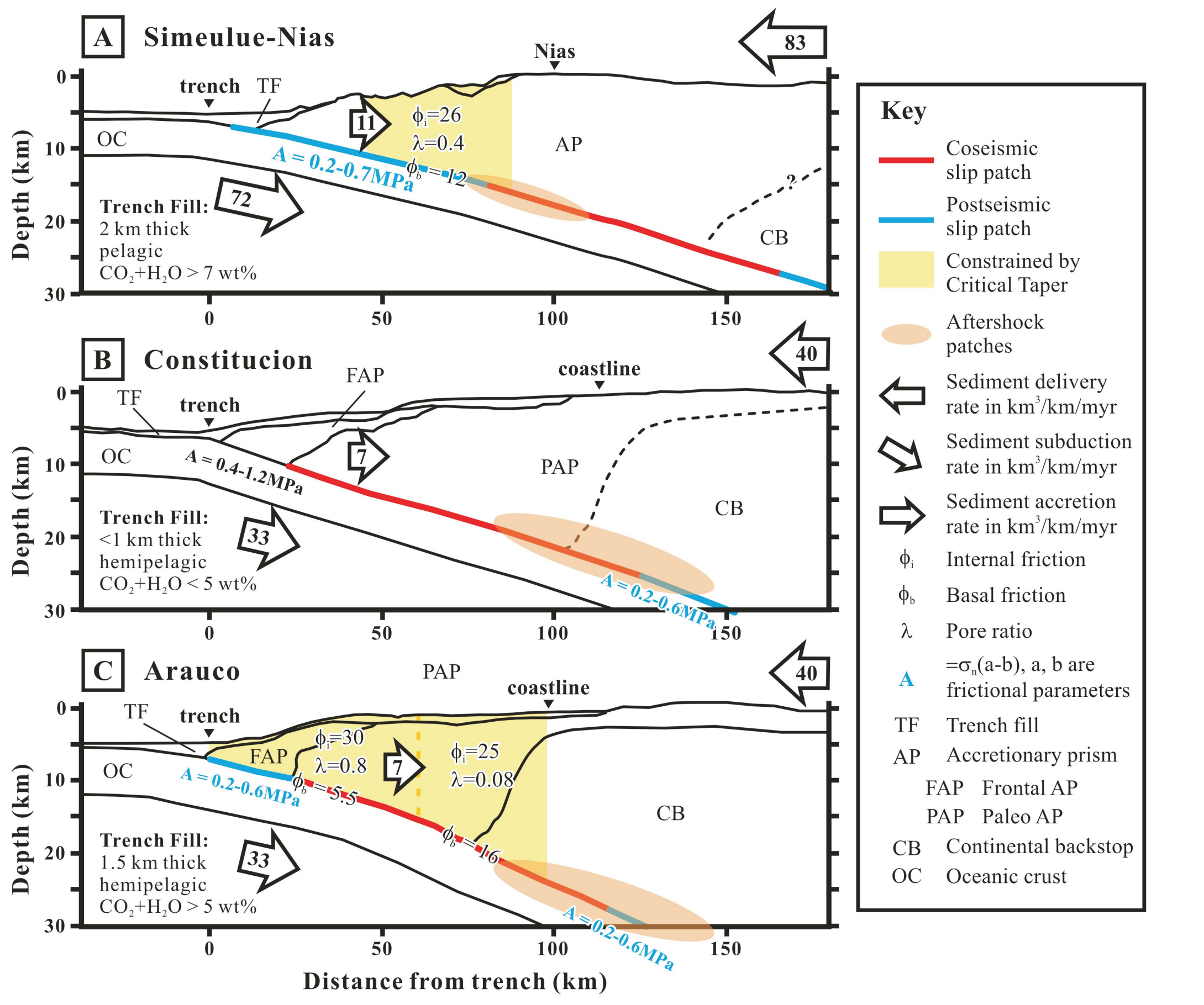

Afterslip of Nias Earthquake
(Hsu et al., 2006)

EXPLANATION I : RANDOMNESS IN PRE-STRESS STATE?



One possibility is that the lack of shallow afterslip for Maule earthquake results from the heterogeneity of pre-stress state in the seismogenic zone. Assume that the pre-stress condition is not symmetric in the up-dip and down-dip directions. If the seismogenic zone margin at which the rupture front reaches receives large stress change, postseismic creep may be triggered. At the other end, if the rupture is trapped by local low pre-stress in the middle of the seismogenic zone and could not propagate to the margin, little or no postseismic slip will happen. This randomness in pre-stress state explains both the post-seismic distribution in Nias and in Maule earthquake. It also implies that the regions where no afterslip were observed may experience creep during a different event.

EXPLANATION II : GEOLOGICAL CONTROL?



If the difference between Nias and Maule is static through multiple seismic cycles, it is likely due to geological control. We compile all the factors deemed related to frictional properties along the subduction interface. Those factors include: morphology (critical taper and thereof implied fault and crustal strength; Suppe 2004), sediment flux (Clift & Vannuchi, 2004), trench fill geochemistry (Hacker 2008; Lucassen et al., 2010). Among them the fault and crustal strength do not appear to have significant difference, except for very low basal friction and high pore ratio around the Arauco Peninsula. The sediment subduction rate is about twice larger in Nias than in Maule, and the trench fill shows higher level of hydration. Sediment thickness or chemical composition may be the controlling factor of heterogeneous velocity-strengthening properties on the shallow part of the megathrust.