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Connecting megathrust earthquake cycle, crustal deformation and volcanism along the Southern Andes

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In despite of the obvious cohabitation of great earthquakes and volcanic eruptions at subduction zones, the mechanisms by which the megathrust seismic cycle, upper crustal faults and magmatic plumbing systems interact are still poorly understood. The Southern Volcanic Zone (SVZ) of the Andes (33°-46°S) is an ideal place to study these connections because of the very active nature of this region, particularly during the last decade, and a well-documented link between long-term tectonics and magmatism. Along the southern SVZ (south of 38°S), the intersection of a dextral trench-parallel structural system (the LiquiÑe-Ofqui Fault Zone) with NE- and NW-oriented faults, respectively creates extensional and compressional regimes that favor the rapid ascent of basic magmas from lower crust in one case (e.g. Llaima volcano) and upper crustal stagnation and differentiation toward acidic magma compositions in the other (e.g. Puyehue-Cordon Caulle Volcanic Complex). Along the Northern SVZ, a dominance of intermediate-to-acidic volcanism is associated to prevailing compressive structures linked with Neogene fold-thrust belts (e.g. Laguna del Maule Volcanic Complex). These connections between upper crustal faults and average composition of volcanoes are only valid under the kinematic conditions prevailing during the interseismic phase of the megathrust seismic cycle, when Nazca and Sudamerican plates are strongly coupled. However, eruptions are statistically more common after large megathrust earthquakes that presumably develop a transient but likely large-scale perturbation of the interseismic stress field. We recognize this apparent paradox and consider the occurrence of the great (Mw8.8) Maule 2010 earthquake as an opportunity to get deeper insights into these relationships. We combine kinematic and dynamic analysis of basement faults at scales ranging from individual volcanoes to the entire arc, with temporal evolution of the deformation field as observed by geodetic data (InSAR and GPS) and crustal seismicity before and after the Maule earthquake. We are currently integrating these observations into a unified conceptual model on the relationship between megathrust earthquake cycle, crustal deformation, active tectonics and volcanism valid for the Southern Andes, which we hope would become significant for the understanding of these connections in other active subduction margins. We will present here a synthesis of this research.