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Monitoring seismic and silent faulting along the Atacama Fault System and its relation to the subduction zone seismic cycle: A Creepmeter Study in N-CHile

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The relationship between crustal forearc faults and subduction zone processes is little understood and therefore the modern seismogenic capacity of these faults cannot be determined. The Atacama Fault System (AFS) is the dominant trench parallel fault in N-Chile with an along strike extent of 1000km. In order to characterize the mode of deformation accumulation and its spatio-temporal distribution, we are continuously monitoring displacement accumulation along active fault branches with a recently installed Creepmeter array. All the installed Creepmeters use 12 mm thick Invar-rod as length standard buried up to 0.7 m depth to reduce the signal to noise ratio, and measure the length standard change across a fault on outcrop scale. The currently deployed 9 sites are designed for displacement detection in the range of 0.001 – 50 mm/yr with a sampling rate of 1/min. The monitored fault branches have been chosen such that 3 Creepmeter sites are located in the Iquique seismic gap of the subduction zone, 5 instruments are located in the segment that recently ruptured in the 2007 Tocopilla earthquake, whereof 2 are located on the Mejillones Peninsula and one is located in the Antofagasta segment that last ruptured in the 1995 Antofagasta Earthquake. This enables us to compare the mode of strain accumulation in different stages of the subduction zone seismic cycle. The first datasets (> 1 yr) show that the instruments both in the Antofagasta and Tocopilla segments display a continuous creep signal equivalent to extensional displacement across the fault zone superimposed by sudden displacement events related to subduction zone earthquakes. The sum of both amounts to 0.02 mm/y – 0.1 mm/y of displacement which is less than predicted by the geological long-term observation. The data from the Chomache Fault located in the Iquique segment shows only a creep signal for the first year after installation with an average extensional displacement rate of 0.05 mm/y. No sudden displacement events have been registered although subduction zone earthquakes occurred during this period in the vicinity of the target fault. These preliminary results may imply that dynamic triggering results in increased fault slip rates but occurs only in forearc segments above recently ruptured subduction zone segments.