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Observing seismic and silent faulting related to a megathrust earthquake cycle: Deployment of a creepmeter array in N-Chile

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Convergent plate boundaries at continental margins belong to the tectonically most active areas on earth and are the potential source of devastating earthquakes and tsunamis. While the bulk of strain accumulates along the subduction interface, significant hazardous deformation occurs by fault activity in the overriding crust. Abundant evidence for active surface faulting in northern Chile has been mapped recently, yet deformation rates can only be calculated on long-term time scales (10000 -100000 years) so far and are often too slow (<1 mm/yr) to be detected by conventional geodetic methods. In order to characterize the mode of deformation accumulation and to determine the relationship between fault creep and earthquakes on timescales according to the seismic cycle we are currently installing an array of creepmeters across active faults with well localized fault traces. We use solid 12 mm invar rods as length standard and measure displacement at 20 – 50 cm below the surface between two firmly anchored piers on both sides of the monitored fault. All instruments installed are equipped with LVDTs (Linear variable differential transformer) and data loggers for year-round autonomous monitoring. The first instrument was installed across an active branch of the Mejillones fault a few days after the 14th November 2007 M=7.8 Tocopilla earthquake. The obtained dataset of one year continuous measurement includes large aftershocks of the earthquake. In 2008 several additional instruments were installed.
The examination of the one year dataset on the Mejillones site shows a good correlation of daily and annual temperature oscillations with thermal expansion and contraction of the creepmeter. Abrupt sub-millimeter scale displacements after temperature correction correlate with aftershocks of the Tocopilla Earthquake suggesting tectonic movement related to seismic events. The preliminary results may hence imply dynamic triggering of increased fault slip rates.